MANUFACTURING R&D: HOW CAN THE FEDERAL GOVERNMENT HELP?

HEARING

BEFORE THE

SUBCOMMITTEE ON ENVIRONMENT, TECHNOLOGY, AND STANDARDS

COMMITTEE ON SCIENCE

HOUSE OF REPRESENTATIVES

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June 5, 2003

MANUFACTURING R&D: HOW CAN THE FEDERAL GOVERNMENT HELP?

THURSDAY, JUNE 5, 2003

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON ENVIRONMENT, TECHNOLOGY, AND STANDARDS,
COMMITTEE ON SCIENCE,
Washington, DC.

The Subcommittee met, pursuant to other business, at 10:15 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Vernon J. Ehlers [Chairman of the Subcommittee] presiding.

COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

Manufacturing R&D: How Can the Federal Government Help?

Thursday, June 5, 2003

10:00 AM – 12:00 PM
2318 Rayburn House Office Building (WEBCAST)

Witness List

Mr. Thomas Eagar
Professor
Massachusetts Institute of Technology

Mr. Larry Rhoades
President
Extrude Hone Corporation

Mr. Herman Reininga
Senior Vice President, Special Projects
Rockwell Collins

Mr. Jay Dunwell
President
Wolverine Coil Spring

Mr. Jason Farmer
President
nLight Photonics Corp.

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HEARING CHARTER

SUBCOMMITTEE ON ENVIRONMENT, TECHNOLOGY, AND STANDARDS
COMMITTEE ON SCIENCE
U.S. HOUSE OF REPRESENTATIVES

Manufacturing Research and Development: How Can the Federal Government Help?

THURSDAY, JUNE 5, 2003
10:00 A.M.–12:00 P.M.
2318 RAYBURN HOUSE OFFICE BUILDING

Purpose

On Thursday, June 5, 2003, at 10:00 am the House Science Committee's Subcommittee on Environment, Technology, and Standards will hold a hearing to review the most serious problems facing U.S. manufacturing with a particular focus on federal research, development, and technical assistance programs.

Manufacturers are raising concerns that the United States is losing its competitive advantage in manufacturing technology, and that this will contribute to permanent job losses to oversees competition. The manufacturing community, industry analysts, and economists believe that significant, extensive changes are afoot in the manufacturing sector beyond the effects of the recent recession. Although U.S. firms, particularly the small and medium-sized manufacturers, cannot compete with the wage differential in many foreign countries, they can compete through factors influenced by the application of technology, knowledge, and skills. There are federal programs designed to help firms develop these capacities. Although effective, the funding levels of these programs have been controversial.

The Subcommittee plans to explore several overarching questions, including:

1) What are the most serious long-run problems facing U.S. manufacturing? To what extent do these represent significant structural problems beyond the recession?
2) To what extent can these problems be alleviated through greater investment in research and development related to manufacturing products and processes?
3) To what extent can federal R&D programs help alleviate the problems faced by manufacturing firms, including small and medium-sized businesses?

Witnesses:

Thomas Eagar, Thomas Lord Professor of Materials Engineering and Engineering Sciences, Massachusetts Institute of Technology, Cambridge, MA.

Larry Rhoades, President, Extrude Hone Corporation, Irwin, PA.

Herman Reininga, Senior Vice President, Special Projects, Rockwell Collins, Cedar Rapids, IA.

Jay Dunwell, President, Wolverine Coil Spring, Grand Rapids, MI.

Jason Farmer, nLight Photonics Corp., Vancouver, WA.

Background

I. Increased globalization has allowed larger firms to divest themselves of their in-house manufacturing capabilities, exposing smaller supply firms to increased foreign competition.

U.S. manufacturers face immediate and growing challenges from foreign competition. These challenges vary from country to country. Many of our trade partners have the advantage of much lower wage rates that enable their firms to trade goods at much lower prices. Some—but not all—nations engage in unfair trade practices such as dumping, or failing to or choosing not to enforce standards of intellectual property. However, many of our trade partners, for example in Europe, Japan, and Singapore, compete with the U.S. based on the quality, technological advantages, or

customer services they offer, despite their lack of a distinct wage advantage. The other "less advanced" countries are investing billions of dollars in their human capital and technology to catch up.

In response to price competition, many large companies are divesting themselves of their in-house manufacturing capabilities and have turned to outsourcing—ordering component parts and raw materials from other companies—to reduce their costs of production (the "foundry" model of manufacturing). This has created large and elaborate supply chains. Globalization, facilitated by advances in communications technology and reductions in transportation costs, has enabled firms to do business with each other across borders and oceans with increasing ease. This has allowed the internationalization of supply chains, as firms around the world are able to sell intermediate goods to larger manufacturers. Since the U.S. is the world's biggest market, foreign firms naturally turn to it for the greatest profit. Many U.S. firms have benefited greatly from this arrangement since they are able to purchase what they need at lower prices. But it has exposed thousands of small and medium sized firms in the U.S. to fierce competition for which they are unprepared. Lately, many large companies in a range of different industries have located their newest factories or entire supply chains abroad.

There are some disadvantages to this dispersed model, most obviously that the risks to just-in-time manufacturing are much greater when the shipping time for components is three to six months and subject to delays, as it is for the automotive supply chain when importing components from Asia or Europe by container. In addition, there are advantages to geographical proximity for product and process development synergies, problem-solving, and generally closer working relationships. The development of clusters, such as information technology in Silicon Valley, California, the automotive industry in Detroit, Michigan, and biotech in Research Triangle Park in North Carolina, was a success because it maximize these advantages. The U.S. is considered to be the model for other countries for clusters, and also for federal-industry-university research and development partnerships and consortia, which can provide a nucleus around which clusters can be developed. Several U.S. states, and many foreign countries, are pursuing their own cluster strategies, with varying success. However, with the loss of key industries or factories, clusters can dissolve, too.

II. Investments in research, development and education are important to increases in productivity in the long-term, but industry's research efforts, which represent the bulk of all domestic investments in R&D, have begun to shrink.

According to the Bureau of the Census, between 1988 and 2000, the manufacturing trade balance for advanced technology products remained positive (though shrinking), whereas all other products went from an annual deficit of $100 billion to more than $300 billion. This may indicate that a key to the U.S.'s exports strength in the long run may lie in higher technology goods rather than lower.

Technology and education drive productivity growth. Sustained productivity growth requires sustained investment in research, development, and education. Our trade partners are making new and significant efforts towards increasing the education level of their workforces, investing in manufacturing-specific research and development, and creating a generally attractive technological environment for manufacturers to site manufacturing and, recently, research and development facilities. The U.S., although still advanced in many areas, does not have all the technological and educational advantages it once did. Increasing global technological capabilities do not bode well for the long-term prospects for the moderate and low R&D-intensive portions of U.S. manufacturing are not good, and even the more "hi-tech" industries are likely to experience increased competitive pressure. Nevertheless, industry experts and economists suggest that the U.S. can compete successfully in global markets in the less R&D-intensive industry areas, like the transportation sector supply chains, by improving supply chain management. The more R&D-intensive industries can compete more successfully, they say, by developing and implementing technology more effectively. For example, in the consumer electronics industry, Sony is famed for its ability to quickly translate new technological developments into improved displays, sound quality, and miniaturization, incorporate them into its model updates, and get them to market faster than other companies.

Today, industry conducts 75 percent of all U.S. R&D, of which the manufacturing sector contributes approximately 70 percent. Industry-based R&D has generally focused on short or mid-term, goal-oriented research, while proposal-driven, long-term research is supported by the Federal Government. Between these two stages of development is the so-called "Valley of Death," where ideas and basic research that theoretically could become useful products are thought to languish for lack of fund-

ing. For the private sector, supporting these types of projects is too risky, according to some, and if good ideas are to be turned into useful products, the government must step in to provide funding. For others, the government should play no role in the development stages beyond basic research.

Generally speaking, the Federal Government today does not fund manufacturing-specific research and development, and its commitment to applied manufacturing-related research has declined. As industrial competition becomes more fierce, the trend in industrial research has been to cut research budgets and focus on an even narrower horizon of innovation. Long-term, high-risk research is what fosters sustained growth, according to most economists. They believe that companies' ability to grow and develop will suffer from these R&D cutbacks.

III. A number of federal programs help manufacturing, but support for some has been weakening.

There are federal programs whose mission is to support manufacturing. The Department of Commerce houses several programs within the *National Institute of Standards and Technology* (NIST) as well as the NIST laboratories themselves, which have a direct impact on manufacturing technology and practices. NIST's two laboratories, one in Boulder, CO, and the other in Gaithersburg, MD, and its extramural grant program have a mission that includes the enhancement of productivity and facilitation of trade. They do this on a budget of approximately $380 million a year. NIST is also responsible for implementing the Enterprise Integration Act of 2002, the purpose of which is to develop and implement standards and protocols to enable major manufacturing industries and their suppliers to electronically exchange product- and standards-related information. This would be an important part of strengthening domestic supply chains and other relationships between firms. Last year, however, Congress allocated no additional funding for this program, and none was requested by the Administration for FY 2004.

Also within NIST is the *Manufacturing Extension Partnership* program (MEP). Although not exclusively a technology program, it does assist small and medium-sized manufacturers in areas involving technological change, lean manufacturing ("lean" principles include perfect first-time quality, waste minimization by removing all activities that do not add value, continuous improvement, flexibility, and long-term relationships), and acquisition of equipment, as well as business organization, and is considered critical in maintaining the competitiveness of small and medium-sized manufacturers. MEP is funded at $106 million in federal funds and requires a state match, but its budget is in jeopardy every year because some see it as a service that would be more appropriately provided by the private sector. In addition, the state budget crisis is threatening the state match for many MEP programs.

The *Advanced Technology Program* (ATP) supports emerging and enabling technologies for improved products and industrial processes that promise significant commercial payoffs and widespread benefits to the Nation. It has been funded in the range of $150–$180 million. ATP has been controversial because some believe that the government has no role in providing funding for research beyond basic research.

Beyond the Department of Commerce, in the Department of Energy, is the *Office of Industrial Technology* (OIT) whose mission is to increase the energy efficiency of the 12 most energy-intensive industrial sectors in the economy, most of which are manufacturing industries, and some of the DOE laboratories have some manufacturing programs. OIT also runs the *Industries of the Future* (IOF) program. The Department of Defense has various programs including the *Defense Advanced Research Programs Agency* (DARPA), and the *ManTech* program, which are oriented towards technology development and the domestication of the defense supply chain, respectively, but are only peripherally associated with commercial products. The *Small Business and Innovation Research* program (SBIR), funded at approximately $1.5 billion, is a multi-agency grant and contracting program intended to assist the commercialization of the products of basic R&D to advance the missions of the agencies. Although not manufacturing-specific, some of the SBIR projects have impacts on products and processes. Some companies say they have found that the size of the SBIR grants is not sufficient to cover the costs of doing research.

IV. Our trading partners also support manufacturing assistance programs.

Our trading partners are starting or are have already established manufacturing-specific R&D initiatives, many of which are modeled on U.S. programs. There are also efforts afoot by such countries as China and India to lure U.S. industrial R&D oversees, where there is an increasing number of highly-trained workers with Ph.D.s and valuable technical skills.

Some examples of manufacturing-specific, non-basic R&D efforts in other countries include: Taiwan's Industrial Technology Research Institute (ITRI), whose nanotechnology initiative alone is $660 million over six years. MITRE Corporation, a U.S. national security research contractor, has recently signed an agreement with the ITRI to establish an innovative R&D center to work on aerospace communications technology. France has a program modeled on the U.S.'s ATP, called the Fund for Technological Research (FRT), funded at approximately $200 million and requiring a 50 percent non-government match. Israel also has an ATP-like program, called the Magnet Program, currently funded at $65 million and requiring a 66 percent non-government match. Japan has an Industrial Technology Development Support Program, which has a 50 percent cost-share requirement, funded at around $380 million. The Netherlands created a new program in 2001 called the Technology Cooperation Program, merging several business and manufacturing-oriented programs. The program will be funded this year at approximately $70 million with a 50 percent cost-share.

While some of these totals may be small relative to U.S. expenditures, for example President Bush has requested $847 million for the U.S. nanotechnology initiative for FY 2004, as a proportion of these countries' GDP and total R&D, the applied sciences get a greater share of government funding than in the U.S. because these countries have articulated policies of economic growth in terms of increased technological competitiveness.

Related Issues

Employment and Productivity

Manufacturing employment has changed little since the 1970s, ranging between 17 million and 21 million workers. Manufacturing's share of the total workforce has declined steadily since the 1950s. This is due in part to the increasing productivity of the manufacturing sector (measured in output per worker), which now contributes 17 percent to U.S. GDP and $1.5 trillion in annual profits. During the economic expansion of the 1990s, the dollar output of the manufacturing sector grew by 47 percent. Simultaneously, productivity rose 31.6 percent, which was more than twice the productivity gains for the rest of the non-farm economy. Real productivity gains are achieved in two ways: technological development, and education. Productivity increases are a double-edged sword, however. Although it increases the efficiency of an company or industry, this efficiency means the industry needs less workers to meet the same demand, one of the reasons why manufacturing employment has remained stagnant, whilst output has increased.

The Economic Downturn

Manufacturing's effect on the economy is bi-directional, as it can lead an economy both into and out of recession. Manufacturing indicators gave the first warnings of the economic slowdown when employment in that sector peaked in 1998. Since then over 2.6 million manufacturing jobs were shed as factories slowed production, closed, or implemented efficiency measures to try to cut production costs. The manufacturing sector accounts for more than 90 percent of the jobs lost since the beginning of the recession. The lack of strength in manufacturing is considered by most economists to be the most important hurdle to getting the economy going again. Durable goods orders fell 2.4 percent in April—the largest amount in seven months—a figure that included a 3.0 percent drop in orders for new automobiles. The continued manufacturing slump has had a profound effect on the economies tied to manufacturing, particularly in the communities where manufacturing plants are located.

The Trade Deficit

The trade deficit is 16 times larger today than it was 20 years ago. The U.S. monthly trade deficit rose to its second-highest level ever in March, at $43.5 billion. (The highest monthly deficit was in December of 2002.) The import of manufactured good constituted $36.5 billion, or 84 percent of the total deficit for the month. Contributing to this figure were the high oil prices, but overall imports of foreign goods were at their highest historic level of $126.3 billion. Of the manufactured goods, computer and electronic equipment, transportation equipment, and apparel posted the largest deficits. The five highest individual country/region deficits were: Western Europe $7.8 billion, China $7.7 billion, Japan $5.8 billion, Canada $5.2 billion, and OPEC $5.0 billion. In 2000, the latest year for which data was available, 14 percent of U.S. imports were from foreign affiliates of U.S. companies. Another 20 percent were imports from the foreign "parents" of U.S.-located companies.

The trade deficit has been exacerbated by the strength of the dollar, which makes it cheaper to buy products from abroad and more expensive for other countries to import U.S. goods. The dollar appreciated 33 percent in international value between

1995 and 2003. The recent fall in the value of the dollar is expected to have a moderate effect on trade. However, this change has not offset the dollar's gains in recent years. Furthermore China and several other Southeast Asian countries considered a threat to U.S. manufacturing have pegged the value of their currencies to the dollar, and thus U.S. trade with many of these nations will not be immediately affected.

Questions for Witnesses

Questions for Thomas Eagar, Professor of Materials Science and Engineering, Massachusetts Institute of Technology.

1) To what extent is manufacturing a critical component of the U.S. economy?
2) What are the most serious long-run problems facing U.S. manufacturing for both large and small firms? To what extent do these represent significant structural problems beyond the recession?
3) To what extent can these problems be alleviated through greater investment in research and development related to manufacturing products and processes? What role should the Federal Government play in this effort?

Questions for Larry Rhoades, President of Extrude Hone Corporation.

1) What are the most serious long-run problems facing U.S. manufacturing? To what extent do these represent significant structural problems beyond the recession?
2) Is there anything in the existing inventory of Federal or State research and development programs that could play a more significant role in establishing a stronger manufacturing-specific R&D and technical assistance base?
3) In addition to current efforts, please provide specific suggestions of what the Federal or State governments could do to assist manufacturing with research, development, and technology in meeting their long-term needs.

Questions Herman Reininga, Senior Vice President for Special Projects, Rockwell Collins.

1) What are the most serious long-run problems facing your industry?
2) To what extent can these problems be alleviated through greater investment in research and development related to manufacturing products and processes?
3) How much of your research and development is geared towards manufacturing?
4) How much do you work with the small firms in your supply chain on manufacturing issues?

Questions for Jay Dunwell, President, Wolverine Coil Spring, Grand Rapids, Michigan.

1) What are the most serious challenges facing your business? What role does technology play in addressing these challenges?
2) Please describe the differences in the problems faced by small-to-medium-sized manufacturers versus large manufacturers.
3) How did the Manufacturing Extension Partnership (MEP) program help you become more competitive?
4) What problems facing small and medium-sized manufacturers today and in the future are beyond the capabilities of MEP to solve? Do you have any suggestions of how the Federal or State governments can help meet these challenges?

Questions for Jason Farmer, nLight Photonics Corp., Vancouver, WA.

1) What are the challenges facing your business now and in the immediate future? For small high-tech start-up manufacturers are most of your competitors domestic or international? If international, do these companies have any inherent advantages over U.S. companies?
2) What are the challenges in raising venture capital for small high-tech firms? How do you convince venture capitalists to provide funding in the gap between a research concept and making a demonstrable product or does the so-called "valley of death" really exist?

3) What changes have you seen in the start-up, high-tech sector during the past few years? What role, if any, can government provide to assist small, high-tech start-up companies?

4) How did the SBIR program assist in the initial development of nLight's technology? What are the good points of the SBIR program? What improvements or changes do you think should be made to the SBIR program?

Chairman EHLERS. I will call the hearing to order. I am pleased to begin today's hearing on manufacturing research and development: what can the Federal Government do? That reminds me of my standard joke when I go back home and speak to my people and say, "I am from the Federal Government, and I am here to help you." But we truly mean it here, and we are very diligently trying to do what we can to improve the manufacturing research and development climate in this country.

Manufacturing is a subject dear to my heart, and more importantly, to the hearts of my constituents in Grand Rapids, Michigan, a hive of manufacturing activity since the Industrial Revolution and currently the proud bearer of the title "Furniture Capital of the Nation." Over roughly 50 percent of all office furniture made in the United States is made within 20 miles of Grand Rapids' city center.

This hearing is an opportunity to discover the most serious long-term problems facing U.S. manufacturing and whether these are structural problems beyond those caused by the recession. In addition, we will learn today whether or not these problems can be solved through a greater investment in research and development. Finally, we will hear about what federal role research, development, and technical assistance programs could play in ensuring the long-range sustainability of U.S. manufacturing.

Grand Rapids, like communities all over the U.S., has been struggling with multiple threats to its industries. Globalization is rapidly changing the way business is done and where materials and components are purchased. And small and medium-sized firms, in particular, are at the mercy of this process. More and more frequently, large companies are purchasing components for their final products from firms overseas where the cost of labor is lower and those components are therefore cheaper.

While the U.S. cannot compete on the wage differential, it must draw on its other assets to keep manufacturing at home. Today, we will look at our research and development assets and how they help manufacturing. The private sector accounts for 75 percent of total R&D investment in the United States, of which manufacturing contributes 70 percent. The vast sum of our national investment, both public and private, in scientific research would suggest that America will always have the technological edge on other nations in commerce, as we have in military capability.

Indeed, productivity growth in the U.S. during the last decade was unprecedented, largely as a result of technological change. And that growth, I might add, also led to incredible economic growth during that same period. But the global challenge to U.S. manufacturing has come partly as a result of other nations achieving technological parity with the U.S. They have been investing specifically to build themselves into manufacturing powerhouses and sell their products here in our country.

We are in a potentially worrisome situation today with the prospect of losing many different industries to foreign competition together with their supply chains and ultimately our R&D. It is my hope that by the end of this hearing, we will have a better idea of what is happening to manufacturing today, what role technology plays in maintaining our competitive edge, and what federal pro-

grams of research, development, and technical assistance could be brought to bear on the problems that confront U.S. manufacturers.

I look forward to hearing from our witnesses about this important topic, and I am especially pleased to have Jay Dunwell, President of Wolverine Coil Spring, which is located in the Grand Rapids, Michigan area, my Congressional District.

[The prepared statement of Mr. Ehlers follows:]

PREPARED STATEMENT OF CHAIRMAN VERNON EHLERS

I am pleased to begin today's hearing on "Manufacturing Research: What Can the Federal Government Do?" Manufacturing is a subject dear to my heart and, more importantly, to the hearts of my constituents in Grand Rapids, Michigan, a hive of manufacturing activity since the industrial revolution and proud bearer of the title of Furniture Capital of the Nation.

This hearing is an opportunity to discover the most serious long-run problems facing U.S. manufacturing, and whether these are structural problems beyond those caused by the recession. In addition, we will learn whether or not these problems can be solved through a greater investment in research and development. Finally, we will hear about what role federal research, development, and technical assistance programs could play in ensuring the long-run sustainability of U.S. manufacturing.

Grand Rapids, like communities all over the U.S., has been struggling with multiple threats to its industries. Globalization is rapidly changing the way business is done and where materials and components are purchased, and small- and medium-sized firms in particular are at the mercy of this process. More and more frequently, large companies are purchasing components for their final products from firms overseas where the cost of labor is lower and these components are therefore cheaper. While the U.S. cannot compete on the wage differential, it must draw on its other assets to keep manufacturing at home. Today we will look at our research and development assets, and how they help manufacturing.

Industry accounts for 75 percent of total R&D in the U.S., and is also why manufacturing contributes such a large share—70 percent—of this private research and development funding, The vast sum of our national investment, both public and private, in scientific research would suggest that America would always have the technological edge on other nations in commerce, as we have in military capability. Indeed, productivity growth in the U.S. during the last decade was unprecedented, largely as a result of technological change. But the global challenge to U.S. manufacturing has come partly as a result of other nations achieving technological parity with the U.S. They have been investing specifically to build themselves into manufacturing powerhouses and sell their products here. We are in a potentially worrisome situation today, with the prospect of loosing many different industries to foreign competition, together with their supply chains, and ultimately, our R&D.

It is my hope that, by the end of this hearing, we will have a better idea of what is happening to manufacturing today, what role technology plays in maintaining our competitive edge, what federal programs of research, development, and technical assistance could be brought to bear on the problems that confront U.S. manufacturers.

Chairman EHLERS. I now recognize the Ranking Member, Mr. Udall from Colorado for an opening statement.

Mr. UDALL. Thank you, Mr. Chairman. I, too, want to welcome all of you to today's hearing, and I want to thank you for taking time away from your companies to appear before the Subcommittee. I hope that you will feel that this time will be well spent as we seek your advice on how the Federal Government can better assist our manufacturing base.

Chairman Ehlers has already outlined the importance of manufacturing to our economy and employment base. He has also cited the challenges facing small and medium-sized manufacturers and the significant job loss that has occurred in this sector over the past two years. I hope that our hearing today will begin the start or mark the start of concrete actions by the Federal Government to assist our manufacturers. I don't want to fall into the trap, I don't think any of us up here do, of—that we have in Washington

of studying the problem and then not taking action. Study alone won't stem the erosion of our manufacturing base.

Lots of other parties have carried out studies that can guide us in our actions. The Manufacturers' Council, the National Coalition for Advanced Manufacturing, and the National Association of Manufacturers have all made a number of recommendations on how the government can assist the manufacturing community. One recommendation that they all make regarding direct assistance is to fully fund the Manufacturing Extension Partnership, the MEP, and the Advanced Technology Program, the ATP. However, we in the Federal Government continue to send very mixed messages to the manufacturing communities and to the states. There is a bipartisan consensus that we need to fund both the Manufacturing Extension Partnership and the Advanced Technology Program yet the Administration continues to target these programs for elimination. And although the Administration has announced that it is studying the long-term health of manufacturing, it will not issue a report until later this year.

I believe that we need now to provide appropriate assistance to our manufacturers. Any serious economic growth strategy has to take measured, targeted steps to provide support to the firms that tend to provide the greatest innovation. I hope that the Science Committee will substantively engage the Administration, developing a unified and coordinated agenda to assist our small and medium-sized manufacturers. That certainly has been the tradition in the history of the Science Committee.

So Mr. Chairman, I want to thank you, and I look forward to hearing from our witnesses today. I would yield back any time I have remaining.

[The prepared statement of Mr. Udall follows:]

PREPARED STATEMENT OF REPRESENTATIVE MARK UDALL

I want to welcome everyone to this morning's hearing, and I want to thank our witnesses for taking time away from their companies to appear before the Subcommittee. I hope they will feel that this is time well spent as we seek their advice on how the Federal Government can better assist our manufacturing base.

Chairman Ehlers has already outlined the importance of manufacturing to our economy and employment base. He has also cited the challenges facing small- and medium-sized manufacturers and the significant job loss that has occurred in this sector during the past two years.

I hope today's hearing will mark the start of concrete actions by the Federal Government to assist our manufacturers. I don't want to fall into the Washington trap of studying the problem and then not taking action. Study alone won't stem the ongoing erosion of our manufacturing base. Many other parties have carried out studies that can guide us in our actions: the Manufacturer's Council, the National Coalition for Advanced Manufacturing, and the National Association of Manufacturers have all made a number of recommendations on how the government can assist the manufacturing community. One recommendation they all make regarding direct assistance is to fully fund the Manufacturing Extension Partnership and the Advanced Technology Program.

However, the Federal Government continues to send very mixed messages to the manufacturing community and the states. There is a bipartisan consensus in the Congress that we need to fund both the Manufacturing Extension Partnership and the Advanced Technology Program, yet the Administration continues to target these programs for elimination. And though the Administration has announced that it is studying the long-term health of manufacturing, it will not issue a report until later this year. I believe that we need to provide appropriate assistance to our manufacturers now.

Any serious economic growth strategy has to take measured, targeted steps to provide support to the firms that tend to provide the greatest innovation. I hope

that the Science Committee will substantively engage the Administration in developing a unified and coordinated agenda to assist our small- and medium-sized manufacturers.

Chairman EHLERS. The gentleman yields back his time. Without objection, all additional opening statements submitted by Subcommittee Members will be added to the record. Without objection, so ordered.

[The prepared statement of Mr. Smith of Michigan follows:]

PREPARED STATEMENT OF REPRESENTATIVE NICK SMITH

I'd like to thank Chairman Ehlers for holding this hearing to examine America's investment in manufacturing research and development. I've been meeting with workers and employers in my district. They and I are troubled about the continuing decline in manufacturing in Michigan and the whole country. Products from China and other countries are taking away our business. The manufacturing sector accounted for 41 percent of non-farm employment in 1946, 28 percent in 1980, 18 percent in 1990, and just 12 percent in 2002. This means that millions of people are being pushed out of manufacturing jobs into service sector jobs that often pay less. With other sectors of the economy weakening—we lost 560,000 high tech jobs in 2001 and 2002 alone—we need those manufacturing jobs now more than ever.

Manufacturing is especially important to the economy because it is a leader in innovation. Manufacturing contributes 57 percent of total U.S. research and development funding. These new technologies often spill over into other sectors of the economy. For example, the technology in ATM machines originated with equipment used on the factory floor.

Manufacturing has made up an almost constant share of total U.S. GDP since the late 1940s. Over that period, it has varied between about 20 and 23 percent of total U.S. output. Recently however, efficiency and productivity growth in the manufacturing sector—much stronger than in the economy as a whole—has created a situation where output has increased at a faster rate than employment. This productivity has grown by 3.4 percent annually since 1983 and risen even higher recently, with manufacturing productivity surpassing 4.7 percent per year from 1996 to 1999.

With these aggressive improvements in efficiency, we would expect the manufacturing sector to be growing faster in the international market. But it has been under attack from foreign competition, much of which seems to be unfair. I've spoken with constituents who say that Chinese companies sell products for less than the raw materials are worth here. Many suspect that these companies are receiving covert subsidies from the Chinese government. We think that a variety of other governments use similar underhanded methods to boost their sales here and reduce our sales in their home markets.

Another problem is the overzealous regulation and taxation imposed by government. One especially harmful action has been the steel tariff imposed by the Administration. Though the increased price of steel has protected some steel workers from foreign competition, it has also resulted in more layoffs in the steel-using industries than the total employment of the steel making industry. With prices rising by 50 percent or more, hundreds of manufacturers that use steel have simply let workers go or have transferred production out of the country where steel is cheaper.

It isn't healthy to have too much of a service economy where we import most of our goods and fewer and fewer people actually build products. One way to improve things for our manufacturers is to do a better, more careful job of negotiating trade treaties and then enforcing them. Another is to end counterproductive tariffs like the one on steel. We need to make sure our taxes and regulations avoid putting our manufacturers at a significant disadvantage. If we don't do something, we could weaken our economy and lose our productive capacity.

In this hearing, we will examine the role that manufacturing research and development plays in improving American productivity and global competitiveness. I recently signed a letter to President Bush asking him to establish a panel of experts to analyze the factors causing the recent decline in U.S. manufacturing. I look forward to learning what this panel of experts think is the problem and why they feel that increasing investment in manufacturing R&D can play a major role in reinvigorating the American manufacturing industry.

[The prepared statement of Mr. Matheson follows:]

PREPARED STATEMENT OF REPRESENTATIVE JIM MATHESON

Mr. Chairman and Ranking Member Udall, thank you for your consideration. Our nation is facing a protracted economic downturn, and manufacturers have been particularly hard hit. It is crucial that the Federal Government assists the smaller manufacturing businesses, which contribute significantly to the economy particularly in my home state, Utah. This is why I am a supporter of the Manufacturing Extension Partnership (MEP) program.

Many small businesses in Utah have benefited substantially from the MEP and in its absence, it is unclear where these companies can go for information, resources, and assistance. Unless the Federal Government is prepared to invest in another, similar program in the immediate future, I am wary of efforts to dismantle or eliminate the MEP.

I agree with many of my colleagues in Congress that if the Federal Government is content to merely study the problems of manufacturers, without providing a plan of action or tangible assistance, then our efforts to improve local economies will necessarily fall short.

I hope that this hearing sheds light on why Federal Government assistance is crucial to small businesses in general and why manufacturers depend on this program in particular, thank you.

Chairman EHLERS. At this time, it is my pleasure to introduce our witnesses for today. And we have a star-studded cast present. I am very pleased to have all of you here, ranging from the theoretical to the practical. First we have Thomas Eagar. He is the Thomas Lord Professor of Materials Engineering and Engineering Sciences at the Massachusetts Institute of Technology in Cambridge, Massachusetts. He is also a member of the National Academy of Sciences Board on Manufacturing and Engineering Design, which is running a new program entitled, "New Directions in Manufacturing."

Our second panelist is Larry Rhoades, the President of Extrude Hone Corporation located in Irwin, Pennsylvania. He chairs the Association for Manufacturing Technology, and is also a member of the National Academy of Sciences.

Third we have Herman Reininga. He is a Senior Vice President for Special Projects with Rockwell Collins in Cedar Rapids, Iowa. His company is a member of the National Coalition for Manufacturing Technology.

Next is Jay Dunwell, whom I have previously mentioned, and I am pleased to introduce him. He is the President of Wolverine Coil Spring located in my Congressional District in Grand Rapids.

Finally, we have Jason Farmer, who will be introduced by Representative Baird.

Mr. BAIRD. I thank the Chairman for this opportunity to introduce Jason Farmer, who is Director of Advanced Technology at nLight Photonics. This is a semiconductor laser plant operated in Vancouver, Washington, my home District. Jason is responsible for all aspects of advanced technology at nLight, including exportation of new concepts, applications, and opportunities that will allow fundamental advances in the field of semiconductor lasers. He was a principle scientist at Aculight Corporation, holds a BS from University of California at Santa Barbara, and an MS from the University of Colorado at Boulder. The products this company makes have the opportunity to revolutionize the telecommunications industry as well as defense and homeland security. And it is precisely this kind of manufacturing opportunity that I think will move us forward into the next economic burst that we are hopeful to see.

And I thank the Chairman for hosting this hearing.

Chairman EHLERS. Thank you for the introduction. Just a brief word about the ground rules. I presume you are all aware that your testimony is limited to five minutes. We have some lights there and there, which will show green during the first four minutes, yellow during the fifth minute, red indicating you should stop. I have borrowed a laser light saber from Mr. Farmer. And so if you stay in the red too long, you are going to be in deep trouble.

We will start our testimony with Mr. Eagar. Could you turn on your microphone, please?

STATEMENT OF MR. THOMAS W. EAGAR, PROFESSOR, MASSACHUSETTS INSTITUTE OF TECHNOLOGY

Mr. EAGAR. Mr. Chairman Ehlers, Members of the Committee, ladies and gentlemen, it is an honor to speak with you this morning to provide my views on the role of technology on manufacturing competitiveness in the United States. Mr. Christopher Musso, a doctoral student at MIT in the engineering systems division, is here with me and has assisted me in organizing our thoughts, many of which relate to his doctoral thesis on innovation in manufacturing industries.

Some people note that manufacturing in the United States is in crisis. If crisis means that the number of direct labor jobs in manufacturing has been decreasing for several decades, then I must agree. But if crisis means that American manufacturing is less abundant and is losing its ability to compete for the best manufacturing jobs in the world today, then I take strong exception to the word "crisis."

Over the past 50 years, we have experienced a manufacturing revolution in the United States at least equal to the Industrial Revolution of the 19th century. An American worker today produces four times as much as her father or grandfather produced in 1950. Over the past two decades, manufacturing productivity has exceeded the gains of all U.S. business by more than one percent per year.

"To live well, a nation must produce well," and we have. Our productivity gains are a phenomenal success, but they have their difficulties. Growth in consumption and exports has not matched these great strides in productivity. As a result, direct labor employment has dropped. Factories have over-capacity, prices have decreased in real terms, and corporate profits have been squeezed or eliminated. This trend is not new. In 1820, 85 percent of the workforce was farmers. Today, it is three percent and declining. We have lost textiles, shipbuilding, consumer electronics, much of our steel industry, and we are starting to decline in semiconductors. I submit that this is a natural process as these industries grow, mature, and decline, resulting in producing commodities on the world market.

The only way for us to survive is to innovate and create new, high-value industries to replace these maturing industries. Technology is the engine that drives the innovation process. Manufacturing is critical to the U.S. economy, because it not only provides new sources of employment, but in the automotive sector, it provides over six spin-off jobs for every direct labor job, according to a University of Michigan study in 1998. The U.S. economic census

notes that the U.S. manufacturing payroll is 14 percent larger than the next two largest sectors, even though manufacturing employs 15 percent fewer people. This 30 percent pay differential matters to many Americans. A nation without manufacturing is like a car without gas: it will not move forward.

The most serious challenge for U.S. manufacturing is the continuing ability to innovate. The world admires our capacity and flexibility to innovate and create new industries. There are three things necessary for innovation: technology, capital, and people. We must have all three. When I ask audiences which of these three is the most difficult, I get near unanimous agreement that the greatest need is in educating our workforce. We must change the cultural premise that learning ends upon graduation from high school or college. Learning is a lifelong process, and the best jobs go to those who never cease their education.

What can the government do to help innovate new industries? We can improve the continuing education of the workforce. We must strive for 100 percent literacy and numeracy. No worker can be left behind. We must balance the non-military federal R&D ratio to avoid the "valley of death" in longer ranged development projects of the 5- to 20-year horizon. The ATP and SBIR programs are steps in the right direction. We must ask our R&D researchers to consider a cost benefit return on investment of taxpayers' dollars. The taxpayers deserve a return on their investment. Knowledge for its own sake is a wonderful goal, but it doesn't necessarily give a return.

In closing, I hope that you will be able to state, as once did Henrico Fermi, "Before I came here, I was confused on this subject. Having listened to your lecture, I am still confused but on a higher level."

Thank you very much.

[The prepared statement of Mr. Eagar follows:]

PREPARED STATEMENT OF THOMAS W. EAGAR

"To live well, a nation must produce well." [1]

A manufacturing revolution has emerged in the past 50 years that is as significant as the industrial revolution of the 19th century. From 1950 to 2000, the average productivity growth in manufacturing in the United States was 2.8 percent per year, and this figure has been accelerating for the past two decades as manufacturing productivity growth has exceeded the average of other sectors by more than one percent per year (please see table below). Stated more simply, a U.S. manufacturing worker can produce four times as much per hour today as compared with fifty years ago. This gain has resulted from competitive pressures, the advent of new technologies, and a series of product and process innovations. It has also resulted in a much higher standard of living for Americans, as products become more useful and more affordable. In order to utilize this new manufacturing capacity, U.S. firms (and others) have expanded their marketing abroad, creating rapid increase in global trade.

[1] Dertouzos, Michael, Lester, Richard, Solow, Robert (1989), *Made In America,* The MIT Press, Cambridge, MA, page 1.

U.S. Average Annual Productivity Gains						
	1950-1960	1961-1970	1971-1980	1981-1990	1991-2002	1977-2002
All US Business	3.3%	3.2%	1.9%	1.7%	2.2%	1.8%
Manufacturing	2.0%	2.6%	2.6%	2.9%	3.6%	3.0%

The perception of a crisis in American manufacturing is the result of one of the most difficult realities of large gains in productivity: additional capacity almost always exceeds increased consumption. This results in an inevitable shift of labor. Industries become more productive as they mature, and competitive pressures increase. These two factors require companies to decrease their workforce and often result in movement of commodity industries overseas. The end result is a loss of jobs in the United States. Displaced workers must shift to new occupations, requiring new skills and abilities. History has shown that this shift can be either detrimental or beneficial to workers; the most important determinant of benefit is the presence of innovative new industries, which, create high value for their markets. The sustainability of growth in the U.S. manufacturing sector is based on the ability of America to continue to innovate. Innovation is the key to a vibrant U.S. manufacturing base and continued generation of new jobs.

Industry-creating innovations can come in many forms—from plastics to consumer electronics to the Internet—but they all depend on the ideas of individuals. As technologies become more complex, the role of science and technology education in the creation of new innovations becomes ever more important because technological breakthroughs depend on the understanding of technology. The greatest challenge facing the United States manufacturing sector is the limited knowledge and ability of its people to create new innovations. Failure to continuously strengthen our knowledge base will result in a declining ability to provide for the wants and needs of our people.

The Importance of Manufacturing in the U.S. Economy

It is difficult to underestimate the importance of manufacturing in the U.S. economy. According the 1997 U.S. Economic census, the payroll of the American manufacturing sector is 14 percent larger than the next two largest sectors (finance and insurance, retail trade) combined, despite having 15 percent fewer employees![2] Some have said that other industries, such as financial services and trade will replace manufacturing in the future. An examination of the economic sectors refutes this argument. There are only four economic sectors that generate material wealth: agriculture, mining, manufacturing, and construction. Other sectors, such as services and trade, redistribute this wealth, and are built on the products created by the wealth generators. Of the four wealth-creating sectors, manufacturing plays a unique role because, unlike agriculture and mining, it is not directly limited by natural resources and, unlike construction, most manufacturing products are easily transferable across national and international borders. As a result, manufacturing is and will continue to be the fundamental base for the economic health and security of the United States.

The economic impact of the manufacturing sector is not limited to direct employment of manufacturing employees. A recent University of Michigan study concluded that more than 6.5 "spin off" jobs (including trade, service, and indirect manufacturing) were created in 1998 for every direct automotive manufacturing job.[3] This illustrates the importance of measuring manufacturing as a generator of wealth instead of as a source of direct employment. When manufacturing is viewed as a generator of wealth, the importance of new innovation is clear. Direct employment in many maturing industries will shrink as productivity increases, and indirect employment can be expected to follow suit. The effects of layoffs in the manufacturing sector will be multiplied by layoffs in other sectors. Conversely, if new, high value industries are created, the indirect impact of manufacturing can be expected to increase, because high value industries create more wealth among workers and soci-

[2] 1997 Economic Census: Summary Statistics for United States 1997 NAICS Basis.

[3] Fulton, Grimes, Schmidt, McAlinden, Richardson, et al. (1998), "Contribution of the Automotive Industry to the U.S. Economy in 1998: The Nation and Its Fifty States," page 28.

ety. The Federal Government can help the manufacturing sector by measuring it as a generator of wealth instead of as a direct employer.

Because of its impact on other industries, manufacturing is the fuel that drives the economy. In today's world of global competition, the economy of a nation without manufacturing will not move forward, it will become stagnant and decay over time. States compete for manufacturing jobs, and other countries are willing to import any capacity that the U.S. doesn't want—manufacturing matters!

The Most Serious Challenge to U.S. Manufacturing: Lack of New Innovation

It was mentioned earlier that the growth of new industries is one of the key determinants of opportunities for a displaced worker. America's workforce wants to work, and takes pride in self sufficiency; displaced workers will seek the best opportunities. If innovative, high-value industries are present, workers will find jobs within them. If they are not present, workers will be forced to take lower paying service jobs. Faced with competitive pressures and globalization, U.S. manufacturing firms must increase productivity in order to survive. However, without nurturing of our knowledge base, there is no assurance that innovation will continue producing new industries, and even less assurance that those new industries will be based in the United States. This is the most serious challenge to the future of American manufacturing.

The United States is the most prolific innovator in the history of nations. This success is clearly not explained by abundant natural resources or geographic location alone. Previous government policy decisions, such as implementation of the free-market system, public education, and infrastructure investment have been crucial to economic advancement and the generation of new ideas, and have helped to harness the willingness and abilities of our people. The attitudes and ideas of our people have been our greatest economic assets, and will become more important as innovations are required to balance the pace of increasing productivity. Future government policy that stimulates innovation will help ensure the creation of new industries. We must provide the incentives to build the foundation for those new industries.

Most of the innovation that results in new industries is based on the combination of new technology and market needs. Technology can be defined as the practical embodiment of knowledge—the useful application of basic science. Thus, in order to create new technological innovations, our workforce must understand existing technology. Education is a lifelong process, and Americans must be endowed with technical knowledge to promote continuous improvement. This does not mean that everyone needs to be trained as a scientist, but rather that a commitment should be made by industry, government, and higher education to increase the knowledge of every worker. It is the skills of the people that drive us forward, so there should be no illiteracy or illnumeracy in manufacturing. Channels and incentives should be created to encourage everyone to enhance their skills. Just as no child should be left behind in America's elementary education, no worker should be left behind in lifelong education.

This enhancement of skills will require investment on the corporate and national level. Any knowledge that is attained in a current job can be expected to help people rise to the challenges of future industries, and will help everyone. An investment in anyone is an investment in the nation. Experience has shown that the confluence of new knowledge and existing products and processes results in better products and more efficient processes—the fruits of innovation. Better education gives workers new tools to improve their jobs, making themselves, their companies, and America more competitive in the global market.

Stimulating Innovation by Investing in Development

The path to commercialization of new technology has three major steps: research, development, and innovation. Research is the mechanism by which new knowledge is discovered. Development is the application of this knowledge into technology that solves practical problems. Innovation is the application and commercialization of developed technology into specific markets, through which industries are born. Each of these steps must be approached differently, and each step involves significant risk. The Federal Government has shown a willingness to bear the risk of basic research by funding projects through agencies such as the NSF and NIH, and has built paths and mechanisms to perform such research in national labs and universities. Entrepreneurs and existing industries have shown a willingness to bear the risk of commercialization of developed technology, and have built paths and mechanisms, such as venture capital, to encourage such commercialization. However, there are very few organizations willing to bear the risk of development, and even fewer mechanisms designed to encourage it. This is unfortunate, because investment in

research is squandered without sufficient development funding to balance the research portfolio.

Development projects have traditionally been viewed as the domain of industry, but competitive pressures of the past 20 years have resulted in a business climate that places a premium on immediate profits. While this push improves many aspects of business, it is detrimental to the development of new technology. For various reasons, development periods for certain advanced technologies, such as new materials, can span 10–20 years.[4] For a company requiring a 17 percent return on investment, a 15-year development period means that the potential must exist to earn more than 10 dollars *per dollar invested.* This is unreasonable for most industries. Furthermore, entire industries can disappear in 15 years, so businesses face significant market risk with advanced development projects. In fact, the pharmaceutical industry, which has a clear market for its products, is one of the few industries that has shown an ability to sustain 10–15 year development periods.

Development is considered to be the "Valley of Death." It has earned this name for two reasons. First, many scientific results go unused because they are unable to attract development funding, and many development projects die early because companies are unable to see the returns necessitated by long development timeframes. Second, academia, where a large portion of federal research is performed, does not respect or reward development: following a path of development can kill careers. It is virtually impossible to get tenure at a top U.S. research university with development projects. Development requires a different type of creativity than science, and that type of creativity is not valued in the current university environment.

The Federal Government can help create innovation in the manufacturing sector by creating policies that bridge the "valley of death" by encouraging development of basic science and by implementing programs that share the risk of development with the private sector. The Department of Defense has an excellent track record of technology development, in part because it has the right ratio of research to exploratory development—roughly equal shares. The DOD avoids squandering its research by maintaining this ratio. The Federal Government can improve innovation by encouraging other research funding agencies to meet the same R:D funding ratio as the DOD.

Because the DOD has clear needs, it requires that each research proposal include a section on potential applications. This forces scientists to focus on realistic and practical uses of new knowledge. The Federal Government can improve innovation by requiring most research proposals to include such sections, but should also require a cost/benefit justification. Taxpayers deserve a return on their investment in research.

Small businesses and individuals have proven to be very effective technology developers. Unfortunately, few small businesses can afford to engage in long-term development projects because of capital constraints. The Small Business Innovation Research (SBIR) and the Small Business Technology Transfer (STTR) programs take advantage of the intelligence, incentives, and flexibility of small groups by sharing the risk of long-term development. The Federal Government can improve innovation by expanding these programs to provide incentives for risk taking with medium and large businesses, as well.

Conclusion: The Federal Government Can Help Manufacturing

The manufacturing sector is crucial to the U.S. economy. It is the sector with the largest payroll, and every direct job in manufacturing creates several indirect and "spin-off" jobs. Because of this, manufacturing is the economic foundation of other sectors, and cannot be measured solely in terms of direct employment.

Competitive pressures and globalization have forced the manufacturing sector to make large investments in improving productivity. Increases in productivity and efficiency bring higher standards of living to societies and better prices for consumers, but also result in reduction of direct manufacturing jobs because capacity often outstrips demand. This reduction is an inevitable outcome of increases in productivity, and is painful in the short term, since workers are forced to find work elsewhere. However, if innovative, high-value industries are present, displaced workers can actually improve their situation by moving to those industries. Innovation is the key to continued increases in the manufacturing sector, and is therefore the key to improvements in the overall standard of living of America. Conversely, a lack of innovation is the most serious challenge facing the U.S. manufacturing base, because

[4] Eagar, Thomas, " Bringing New Materials to Market," *Technology Review,* February/March 1995.

global competition will continue to force increases in productivity, movement of commodity manufacturing overseas, and displacement of American labor.

The American workforce must understand current technology in order to create new product and process innovations. This understanding will become more important as technologies become more advanced, and the mobility of the workforce will be limited by the knowledge of individual workers. The United States must invest in continuing education of its workers if it is to maintain its competitive advantage.

Long-term development projects are a "valley of death" for many advanced technologies, because there are no clear development channels. Industry cannot afford the risk of 5- to 20-year development projects. Small businesses, which have been the most effective technology developers, lack the resources to even attempt such projects. The culture of academia is skewed heavily toward science, and the type of creativity necessary for development projects is neither encouraged nor rewarded.

The Federal Government can enact structural changes that will improve the ability of industry and academia to create industry-creating innovations. Most of these changes deal with two major problems: the limitations of our people in dealing with technology, and the lack of technology development structure. These changes include:

- *Measuring manufacturing as a generator of wealth instead of as a direct employer,* to help policy makers understand the true impact of changes in the manufacturing sector.
- *Improving continuing education of manufacturing workers,* to help improve direct product and process innovation, and to prepare workers for future industries. Every worker should be numerate and literate.
- *Balancing federal research budgets between research and development,* so that research expenditures aren't squandered by failure to fully develop the new knowledge.
- *Requiring researchers to include potential applications and cost/benefit justification,* to ensure a favorable return on taxpayer investment.

Christopher Musso, Engineering Systems Division, Massachusetts Institute of Technology, contributed to this testimony.

Chairman EHLERS. Thank you very much. And I have heard many stories, since I am a physicist, but that is one of the better ones.

Mr. Rhoades.

STATEMENT OF MR. LAWRENCE J. RHOADES, PRESIDENT, EXTRUDE HONE CORPORATION

Mr. RHOADES. Good morning. Manufactured products are the currency of international trade. The efficiency and value added in a nation's manufacturing operations defines the standard of living for the entire nation. America is the world's largest and most open market. It is U.S. manufacturers nose-to-nose with their competitors on the shelves at Wal-Mart or the showroom of your Chevy dealer. Products made in America sit side-by-side and must compete to do so with those from Brazil, Hungary, India, and China.

Yet as a nation with one of the world's highest labor costs and standards of living, we produce all our food needs and export, and why? Agriculture, which was once a very labor-intensive activity, changed in America to become highly automated, highly scientific. The technology and the equipment used in agriculture today combine with an infrastructure of technical support and the most modern methods made this so.

We can do the same in manufacturing, but we must find new methods, new approaches, new technologies, and we must understand how those new manufacturing technologies can be used to make new and better products that deliver more value to their buy-

ers. We must drive the manual out of manufacturing and capture America's innovative spirit to transform it into "innofacturing."

Emerging industrial nations have clear, national policies to encourage the competitiveness of their manufacturing sectors. In contrast, the U.S. is in need of a coordinated national program sized sufficiently to provide a manufacturing technology infrastructure that would enable U.S. manufacturers to compete. And U.S. manufacturers could compete. There are rational and appropriate responses to the massive loss of manufacturing jobs, loss of exports, and loss of federal tax revenue that is inherent in this systemic and seismic shift in how the world makes things.

Although tax policy that encourages investment surely helps, it does not directly respond to what is happening. In my view, we must also mount a national offensive to do the following. First, recognize that we are building a national manufacturing technology infrastructure, one that is accessible to U.S. manufacturers and enables them to make things with methods that are appropriate to U.S. economics, with the size and dynamics of our markets and that embraces America's unique creativity. There must be critical mass to the effort. We are building highways and bridges, in a sense, and we need an integrated system to really benefit from our investment. As the Nation's taxing authority, the Federal Government takes a share wherever the benefits of this investment fall within the U.S. economy. The private sector can not and will not build the needed manufacturing technology infrastructure alone any more than they could or would build a road system or a school system.

Secondly, I feel we must focus the investment on innovatives. These include universities, and they include the manufacturing equipment builders, the specialty material suppliers, and the tooling suppliers, and the technology support organizations that make up the manufacturing technology infrastructure. The act as resources and champions for new ideas and new methods that all U.S. manufacturers can turn to for implementation support, accelerating the transformation of new science into new tools for America's factory floors.

I feel that we should support, indeed substantially expand support for defense manufacturing technology programs to strengthen the U.S. defense industrial base, that we should expand and strengthen NIST's MEP program that provides critical assistance to small manufacturers that now perform the bulk of U.S. manufacturing tasks, NIST's ATP program with a special new focus on creating a menu of innovative manufacturing processes from technology providers along with innovative products that are enabled from these new methods from end-product manufacturers.

And finally, support creation and expansion of open-membership U.S. industry collaborative R&D consortium, like the National Center for Manufacturing Sciences, that help their members learn how to do cross-industry collaborative manufacturing technology development, uniting technology users, who design and manufacture end products, with technology providers, who pioneer the development of new manufacturing methods that enable those products, and together help to define and create the manufacturing technology infrastructure of tomorrow.

Thank you for the opportunity to be here and to express my concerns and hopes for a manufacturing technology infrastructure that would unleash America's ability to build its future.

[The prepared statement of Mr. Rhoades follows:]

PREPARED STATEMENT OF LAWRENCE J. RHOADES

Manufactured products are the currency of international trade.

The efficiency, and value added in, a nation's manufacturing operations defines the standard of living for the entire nation. America, as the world's largest and most open market, pits U.S. manufacturers nose to nose with their competitors from all parts of the world. On the shelves of WalMart, or the showroom of your Chevy dealer, products made in America sit side-by-side, and must compete to do so, with those from Brazil, Hungary, India and China.

This is a boon to consumers. Low cost manufactured goods allow us to have "more for less." And, on balance, it is a boon to those workers in emerging industrial nations who are fighting their way out of subsistence agrarian economies through manufacturing. Manufactured products, along with information technology products, provide a special opportunity for economic growth because they permit human effort—both physical and intellectual—to be moved through space and time—and offered half way around the world in a market where that human effort has a high value. And this has implications for the entire national economy.

A haircut in Wushi is pretty much the same quality as a haircut in Washington. Yet, outside of the fancy hotels, it costs less than ten percent of the cost of a Georgetown haircut. Why?

Because the value of that same labor, the same effort with equivalent skills as the barber, working in a *manufacturing* operation has the same relative productivity to his counterpart as the difference in the cost of the haircuts. As America loses its manufacturing productivity advantage, the Washington barber's ability to buy things will fall to the level of his Wushi counterpart. And America is well on its way to losing its productivity advantage. Not only is the direct labor used in manufacturing less expensive, massive new investment has equipped China and Brazil and Hungary with some of the world's newest and most modern plants.

Some say, in time, the market price of labor in those emerging industrial nations will rise as well. But consider the scale of the labor supply. In the past 25 years, 1.5 billion *workers,* not just people, but workers, have entered the global market from Brazil, Eastern Europe, India and China alone. This is nearly three times as many people as are in the current G7 countries that make up the bulk of the current market for manufactured products. It will be a long time indeed for that labor market to see broadly rising labor costs.

Some say that the more advanced economies will simply substitute capital for labor. Yet the data doesn't support this. I chair the Association for Manufacturing Technology which comprises America's machine tool industry—the companies who build the machines that make things on the factory floor. So, I am painfully aware of the plunge in U.S. machine tool consumption. In the past five years, U.S. consumption of machine tools has fallen by 63 percent so that the USA—the world's "strongest" economy—ranks fifth in its investment in manufacturing equipment. The first, of course, is China who last year spent one and a half times as much on manufacturing equipment as the U.S.

To be honest, just buying more capital equipment isn't enough. We need new *ways* to make things, new technologies for manufacturing. And our manufacturing enterprises must have dependable guidance in changing *how* they make things—not just advice on the technologies, but help in understanding the implications of those technologies on the business practices that organize production.

As a nation with one of the world's highest labor costs—and standards of living—we produce all our food needs *and* export. Why? Agriculture, which was once a very labor intensive activity, *changed* in America to become highly automated, and highly scientific. The technology of the equipment used in agriculture today, combined with an infrastructure of technical support in the most modern methods, made this so.

We can do the same in manufacturing. But we must find new methods, new approaches, new technologies—and we must understand how those new manufacturing technologies can be used to make new and better products that deliver more value to their buyers. We must drive the "manual" out of "manufacturing" and capture America's innovative spirits to transform it into "innofacturing."

And, U.S. product designer/manufacturers must embrace these new manufacturing processes to make products with features and functionality that weren't previously possible.

Most of U.S. manufacturing today is done by small and medium-sized enterprises—a substantial shift over the past twenty years, as large Fortune 500 manufacturers "down-sized" and "out-sourced." Increasingly, it is this sector of the economy that is locked in competition with low labor rate emerging industrial nations (and those nations have clear national policies to encourage the competitiveness of their manufacturing sectors).

In contrast, the U.S. is in need of a coordinated national program sized sufficiently to provide a manufacturing technology "infrastructure" that would enable U.S. manufacturers to compete. And U.S. manufacturers *could* compete. There are rational and appropriate responses to the massive loss of manufacturing jobs, exports and federal tax revenue that is inherent in this systemic and seismic shift in how we make things.

Although tax policy that encourages investment surely helps, it does not directly respond to what's happening. In my view, we must also mount a national offensive to do the following:

1. Recognize that we're building a national manufacturing technology "infrastructure." One that is accessible to U.S. manufacturers and enables them to make things with methods that are appropriate to U.S. economics, with the size and dynamics of our markets, and that embraces America's unique creativity. There must be critical mass to the effort. We are building "highways and bridges," in a sense, and we need an integrated system to really benefit from our investment.
2. Recognize that it is an appropriate investment on behalf of the U.S. taxpayer and one that cannot rationally be made by the private sector, who must recognize that a solo investment in the manufacturing technology menu is unlikely to be able to be "harnessed" to allow the pioneer, who risked the investment, to "toll" the benefits of that investment and reap a reward. The benefits will pass largely to the technology users and their customers and ultimately to the end product consumers, who will enjoy more functional and cost effective products and who, in the end, *are* the taxpayers. Patents and copyrights on manufacturing methods do not provide, cannot provide, sufficient protection to allow this recovery and reward for the innovator—typically a small focused company.

   As the Nation's taxing authority, the Federal Government takes a share wherever the benefit falls within the U.S. economy. The private sector cannot and will not build the needed manufacturing technology infrastructure alone, anymore than they could or would build a road system or a school system.
3. Focus the investment on *innovators* in industry and research centers (e.g., universities). The innovations lead to pilot production sites which lead to full production facilities and finally to industry "clusters" in the U.S.
4. Structure the investment so that it includes research centers generating "new science" and influential (and probably large) product designer/manufacturers who will design products that exploit innovative manufacturing techniques. But center the investment on the usually smaller companies that act as the "technology providers" to the U.S. industrial base. These are the manufacturing equipment builders, the specialty materials and tooling suppliers, the technology support organizations that make up the "manufacturing technology "infrastructure" of the Nation. They act as resources and champions for new ideas and new methods that all U.S. manufacturers can turn to for implementation support, accelerating the transformation of "new science" into "new tools" for America's factory floors.
5. Support, indeed substantially expand:
   (a) Defense manufacturing technology programs to strengthen the U.S. defense industrial base.
   (b) NIST's MEP program that provides critical assistance to the small manufacturers, that now perform the bulk of the U.S. manufacturing tasks, so they can identify, understand and successfully implement modern manufacturing methods and practices that are appropriate—indeed that exploit—U.S. manufacturing capability advantages.
   (c) NIST's ATP program with a special new focus on creating a menu of innovative manufacturing processes from technology *providers* along with innovative products that are enabled by these new methods at influential (i.e., probably "large") end-production designer/manufacturers who are technology *users*.

(d) Support creation and expansion of open membership U.S. industry collaborative R&D consortia, like the National Center for Advanced Manufacturing, who help their members learn how to do cross industry collaborative manufacturing technology development, uniting technology users who design and manufacture end products with technology providers who pioneer the development of new manufacturing methods and together help to define and create the manufacturing technology infrastructure of tomorrow.

Thank you for the opportunity to be here and to express my concerns and hopes for a "manufacturing technology infrastructure" that would unleash America's ability to build its future.

Chairman EHLERS. Thank you very much.

Mr. Reininga.

STATEMENT OF MR. HERMAN M. REININGA, SENIOR VICE PRESIDENT, SPECIAL PROJECTS, ROCKWELL COLLINS

Mr. REININGA. Good morning, Mr. Chairman, Subcommittee Members. Thank you for this opportunity.

Rockwell Collins is an avionics and communications provider for both the military and commercial aviation industry. Fifty percent of our business is military and is doing quite well today. All airlines, at the present time, are losing money. The domestic and global economies remain sluggish since 9/11, and our European competitors are receiving large governmental supplements in aviation. The Far East customers want offsets to build their products in their country. Capital investments have been delayed. Research investments and manufacturing process have been reconfigured, and our supply chain is now under new vulnerabilities and weaknesses.

Even with this environment, we are performing at the 90 percent level of our markets, but maintaining this position creates major challenges for Rockwell Collins. Investments in manufacturing processes and technologies are required for the utilization of new technology projects. Manufacturing is the transformational link, bringing new ideas, technology advances, and creativity to the market. Public and private leadership, linking manufacturing to innovation, is a key step to future productivity improvements and a competitive advantage.

We can compete on new technology if we have developed it, especially if that is disruptive technology. We have minimal display technology and manufacturers in the U.S. We procure our CRTs and our LCDs from the Far East. Display glass is almost entirely produced in the Far East. Projection displays, or 3-D holographics, are examples of disruptive technologies that we can compete on.

Rockwell Collins has targeted five areas for manufacturing research and development. We will invest in emerging technologies and intelligent enterprise systems, utilize the common factories for both military and commercial products. The old models for time to market and unique factories to do work are no longer a requirement and will not work today. And we require new advanced transformation concepts. Technologies, such as nanotechnologies or embedded parts and circuit cards, are examples, which we are pushing. We can not compete on raw printed circuits, which we produce today. Ninety-five percent of the circuit cards are produced outside the United States.

We can compete for circuit card production if the process is for embedding parts or mass customization or production at the point of need are successfully obtained and affordably met. Keys to meeting these requirements are enabled by eliminating hand-offs and making all intelligent systems and knowledge management processes seamless.

Fifty percent of Rockwell Collins' material comes from small businesses. With the reduced number of new aircraft and the reduced retrofits, our supply base is changing. With the lower volumes and the change in type of parts due to new technologies, it has forced our suppliers to look to different markets. We utilize our supply chain during our design process, which improves our interoperability and our availability, but our increase in military avionics has not been able to offset the decrease in our commercial operations. And that gap is continuing to widen.

Small enterprises sometimes lack the incentive, finances, and technical resources to improve cost and cycle times. The Air Force's ManTech program used for the JDAM missile is an exception and it provided cycle time reductions of 60 percent and 45 percent for inventory reductions and may be used as a model.

What can the Federal Government do? Rockwell Collins is working with a consortium called the Defense Manufacturing Technology Program, which is recommending increased collaborative development and funding for DOD ManTech. I have attached to my notes a report, which describes the industrial transformation key to sustaining productivity boom. This was derived from a planning session of 44 companies and 26 other organizations on increasing manufacturing productivity and competitiveness in the U.S. industry. Rockwell Collins obviously participated.

And I have attached a proposal for the Next Generation Manufacturing Technologies Initiative, transforming the U.S. manufacturing base. The proposal includes the need for a high-level advocate for manufacturing within the Administration, which would help stimulate public/private collaboration. Taking such steps, you would accelerate the rate of manufacturing innovation, stimulate investments in manufacturing equipment, improve the workforce skills, and create a voice in the Federal Government to ensure continuation of manufacturing productivity and growth.

Thank you.

[The prepared statement of Mr. Reininga follows:]

PREPARED STATEMENT OF HERMAN M. REININGA

Good Morning.

Rockwell Collins is an avionics and communications provider for both the military and commercial airline industry. Fifty percent of our business is military and is doing quite well. All airlines at the present time are losing money; the domestic and global economies remain sluggish since 9/11. European competitors are receiving large government supplements in aviation and the Far East customers want offsets to build products in their country. Capital investments have been delayed, research investments in manufacturing processes have been reconfigured, and our supply chain now has new vulnerabilities and weaknesses. Even with this environment, we are performing in the 90 percent level of our markets and S&P 500 Peers. Maintaining this position creates major challenges for Rockwell Collins.

Investments in manufacturing processes and technologies are required for utilization of new technology products. Manufacturing is the transformational link: bringing new ideas, technology advances and creativity to market. Public and private leadership, linking manufacturing to innovation, is the key step to future produc-

tivity improvements and a competitive advantage. We can compete on new technology if we have developed it, especially disruptive technology. We have minimal display manufacturers in the U.S. We procure our CRT's and now our LCD's from the Far East. Display glass is almost entirely produced to in the Far East. Projection displays or 3–D Holographics are examples all of disruptive technologies where we can compete.

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Technologies such as nanotechnology's or embedded parts in circuit cards are areas which we are pursuing. We cannot compete on the raw printed circuit cards which we produce today. Ninety-five percent of circuit cards are produced outside the U.S. We can compete for circuit card production if new processes for embedding parts, mass customization and production at point of need are successfully and affordably met. Keys to meeting these requirements are enabled by eliminating handoffs and making all intelligent systems and knowledge management processes seamless.

Fifty-five percent of Rockwell Collins materiel comes from small businesses. With the reduced number of new aircraft production and reduced retrofits—our supply base is changing. With the lower volumes and the change in type of parts—due to new advanced technology—it has forced our suppliers to look to different markets. We utilize our supply chain during our design process, which improves our interoperability and availability. BUT—our increase in military avionics has not been able to offset the gap established by the downturn in commercial avionics. Small enterprises typically lack the incentive, finances and technical resources to improve costs and cycle times. The Air Force's MANTECH program as used for the JDAM missile, is an exception and provided cycle time reductions of 60 percent and 45 percent inventory reductions and can be used as a model.

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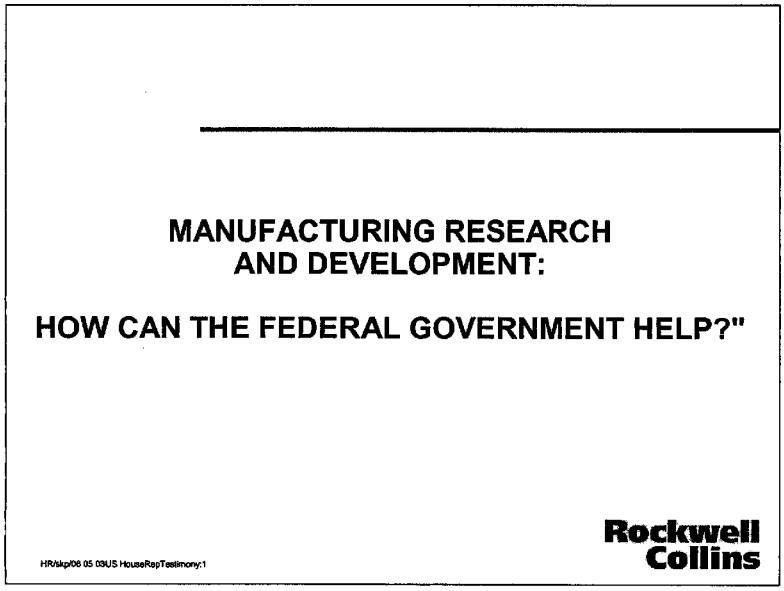
Thank you for your time.

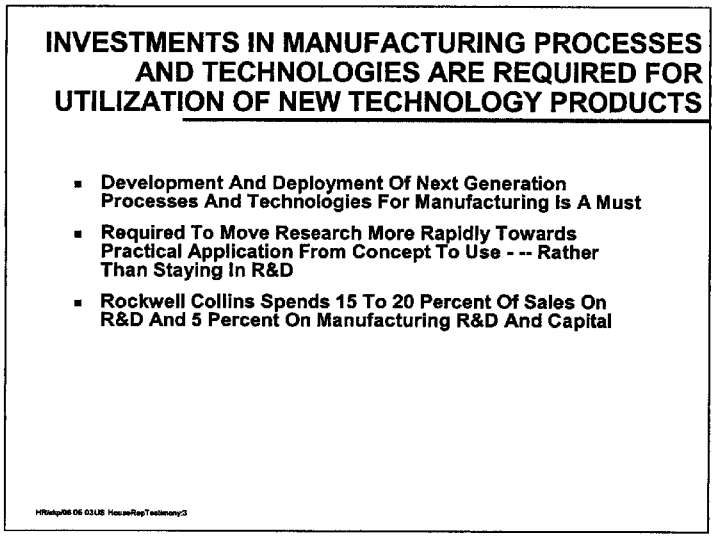

MANUFACTURING RESEARCH
AND DEVELOPMENT:
HOW CAN THE FEDERAL GOVERNMENT HELP?"
HR/skp/06 05 03/US HouseRepTestimony:1
Rockwell
Collins

AVIONICS INDUSTRY IS FACING SERIOUS PROBLEMS AND CREATES MAJOR CHALLENGES FOR ROCKWELL COLLINS

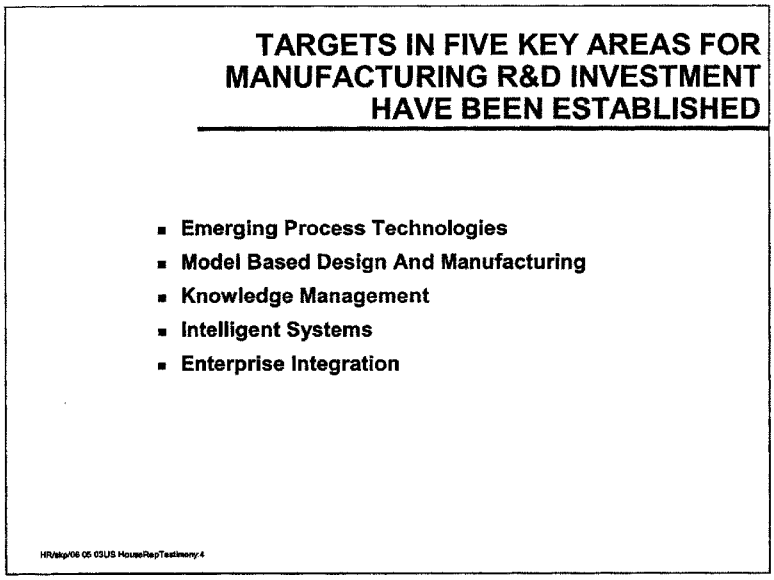
- Domestic And Global Economy Remains Sluggish Since 911 With Avionics Industry Severely Affected
- Declining Customer Investment In New Products Yet Needed To Maintain Technology Development
- Sharpened Competition From Low-Wage Countries With Significant Capital Investment
- Capital Investments In New Manufacturing Technology Have Been Delayed
- R&D Investments In The Manufacturing Processes And Technologies Have Been Reconfigured
- Changing Supply Chain Presents New Vulnerabilities And Weaknesses

HR\skp\06 05 03\US HouseRepTestimony:2

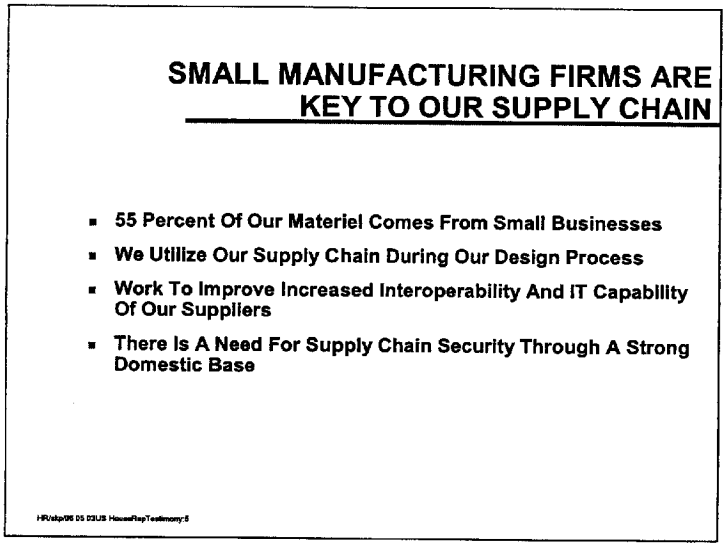
- 50% Business Is Military And Is In Good Shape
- All Airlines Are Losing Money
- Europe Competitors Are Receiving Large Government Supplements
- Far East Is Wanting Off-sets To Buy U.S. Avionics
- Supply Chain Looking For New Markets
- We (Rockwell Collins) Are Performing In The 90% Level Of Our Market; S&P 500 Peers



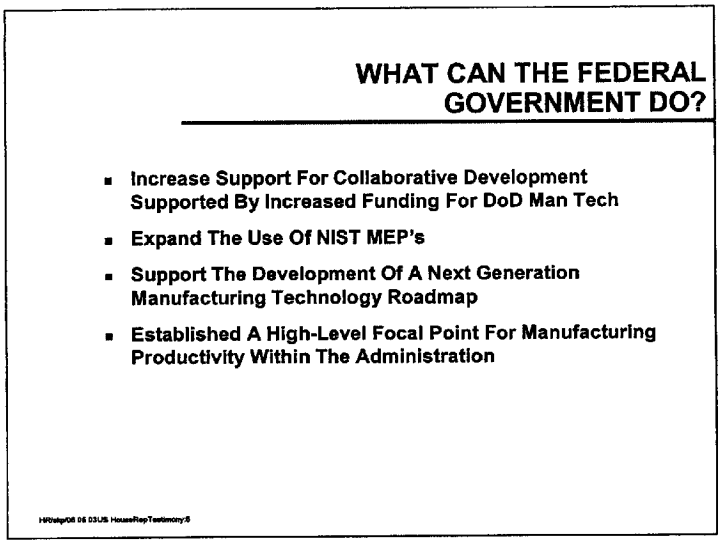
- **We Cannot Compete On Low Labor/High Capital Countries (Silicon Foundrie)**
- **Examples Displays – From CRT's - LCD's To What Active – Diodes (Display Glass Provided In Far East)**
- **We Can Compete On New Technology If We Have Developed It. Especially Disruptive Technology**



- Nano Technology
- Embedded Parts In Circuit Boards – Cannot Compete On PCB's But New Processes We Can
- Projection Displays – 3D Holographic
  - More Software Than Hardware
  - One Display Multifunctions
- Mass Customization And Production At Point Of Need Are Requirements For The Future
- Enable Flow By Eliminating Handoffs And Making Process Seamless



- **Major Change In The Aviation Supply Chain**
- **The Number Of Neo Airplanes Has Dropped Dramatically**
- **Military Aircraft Is Not Filling The Gap**
- **Type Of Parts And Lower Volumes Have Forced Suppliers To Look At Different Markets**



- **NAC FAM – Report**
- **NGM – Letter**
- **Mantech – Military Market Is Increasing And Increased Demand For New Technology Is A Must**
- **Gate-M Is Doing Great Things But A High –Level Focal Point Would Allow A Focus For Manufacturing Technology**

6/3/2003

Next Generation Manufacturing Technologies

Transforming the U.S. Defense Manufacturing Base

INTRODUCTION

The purpose of the Next Generation Manufacturing Technologies (NGMT) initiative is to chart and initiate the transformation of the US defense industrial base by investing in high-leverage, high-impact manufacturing initiatives that enable the defense industry to rapidly accelerate technology transition. The focus is manufacturing science and technology, an area in desperate need of sustained investment to meet the requirements of the future forces envisioned by the Department of Defense (DoD).

THE NEED

The continued world leadership of the US relies heavily on the capabilities of the defense industrial base and the effective use of advanced technology to maintain and accelerate productivity and performance growth. Over the past decade commercial industries have taken the lead in product and process innovation. The ability to quickly transition commercial technologies to defense industry use has met with only limited success. Furthermore, the percentage of R&D investment from the DoD and defense industry in manufacturing science and technology has continued to decline. Yet, the defense industrial leaders have continued to migrate to a role of final assembly, with increased reliance on suppliers, both on and offshore. This is leading to a loss of technical leadership in manufacturing knowledge, skills, and capabilities. It is imperative that the transformation of the defense industrial base begins and proceeds hand-in-hand with the DoD as the military moves toward "capabilities-based planning" and "effects-based operations". The need is highlighted in the report "Transforming The Defense Industrial Base: A Roadmap" published by Deputy Under Secretary of Defense (Industrial Policy) Feb 2003. "The department ought to conduct a systematic assessment of critical technology requirements in each operationally effects- based industry sector in order to provide senior department decision makers and the industrial base visibility into sought after capabilities. . ." This statement defines an objective of this initiative

THE PROPOSED SOLUTION

The NGMT initiative will build on existing Defense efforts and will undertake a research agenda to advance transformation concepts. The research agenda will advance important DoD goals, such as:

- Accelerating the development of new dual-use industries vital for realizing DoD national security objectives;
- Reducing the cost and speeding the technology insertion for new military and space systems;
- Improving the efficiency and reliability of the national manufacturing infrastructure to respond to Homeland Defense and Homeland Security challenges.

The initiative targets 6 key areas for DoD R&D investment:

1. Emerging Process Technologies. This will catalyze ongoing efforts in meso-scale manufacturing, nanotechnology, biomedical manufacturing, bioprocessing, and new material developments.
2. Intelligent Systems. This area will expand investments in microactuator technologies, perception and reasoning systems, and improve the integration and interface systems required for the effective use of these capabilities.
3. Model based Design and Manufacturing. This will support research in the theories and models that can be used to improve the soundness of the decisions under high uncertainty or risk that exist when dealing with complex processes.
4. Enterprise Integration. This will support the development of self-integrating systems, decision theory, and advances in measurement and standards necessary to enable the efficient exchange of information throughout the supply chain.
5. Knowledge Management. This area will support work in the application of expert systems, autonomous agents, emergent systems, and other forms of applied intelligence to assist the conversion of data to knowledge.
6. Safe, secure, and reliable manufacturing operations. This will support the development and adaptation of technologies, processes, and practices to ensure that manufacturing operations are protected from intrusion or interruption.

Working closely with the Manufacturing Technology (ManTech) divisions of the DoD, the initiative will engage a broad range of stakeholders, formulate a national investment strategy, and develop technology roadmaps in each of the six areas to guide future investment and development. In addition, initial work will begin with manufacturing demonstrations in two of these target areas. The initiative will maintain close coordination with other related programs and initiatives, such as the Government Agencies Technologies Exchange in Manufacturing Program (GATE-M) and industry ManTech Coalition.

NACFAM
National Coalition for Advanced Manufacturing

Industrial Transformation: Key to Sustaining the Productivity Boom

A White Paper

May 30, 2003

Prepared by:

National Coalition for Advanced Manufacturing
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For additional copies contact NACFAM at: 202-429-2220

National Coalition for Advanced Manufacturing

NACFAM is an industry-led, non-profit 501(c)(3) education, research, and services organization committed to enhancing the productivity and competitiveness of U.S.-based manufacturing. NACFAM's goal is the accelerated development and deployment of advanced technologies and related workforce skills and knowledge within all tiers of the U.S. industrial base.

NACFAM provides leadership in developing public policies and programs in areas directly related to the manufacturing process; increased R&D investment in manufacturing science and technology; workforce skills assessment and certification; and technical assistance to smaller suppliers.

Founded in 1989, NACFAM has built a unique, public-private community of over 1,500 corporations, 20 national trade associations, and 350 non-profit organizations that offer productivity enhancing services to manufacturers: Federal labs and university research centers in the field of R&D; community and technical colleges in the field of workforce education and training; and manufacturing extension services in the field of supply chain optimization.

Industrial Transformation: Key to Sustaining the Productivity Boom

Executive Summary

Manufacturing is the primary source of productivity growth and remains critical to the nation's future prosperity and security. Yet, U.S.-based manufacturers are facing a crisis today as significant as the competitiveness crisis of the 1980's—a crisis marked by a steep decline in business investment, a sluggish economy at home and abroad, and sharpened competition from low wage countries, especially China.

To deal with this new set of challenges, this paper takes the view that the U.S. can compete successfully with low-wage countries if industry and government rally around two basic goals: (1) increase labor productivity by greatly accelerating the use of advanced technologies and (2) leverage national resources through a major expansion of public-private partnerships.
As the central elements of that strategy, NACFAM's Advanced Manufacturing Leadership Council recommends the following measures:

- ***Move global competitiveness higher on the national agenda and establish a high-level advocate for manufacturing within the Administration***
- ***Develop and deploy next generation process technologies: "A New Tool Kit"***
- ***Better enable American workers to keep pace with technological change***
- ***Decrease supply chain vulnerability and support the nation's smaller suppliers***

This paper contains specific policy suggestions for achieving each of these goals.
Taking such steps will accelerate the rate of manufacturing innovation, stimulate investment in the most advanced manufacturing equipment, continually improve workforce skills and create a voice in the federal government to ensure the continuation of manufacturing-friendly public policies. The overarching effect of implementing these recommendations would be the reduction of unit labor costs made possible by high rates of productivity growth, thereby enabling U.S.-based manufacturers to be competitive in any industry sector where they choose to do business.

* * * * * *

Introduction

In the 1980's, Japan and the Asian Tigers threatened US industrial leadership with a global economic competitiveness crisis. US industry rose to that challenge as evidenced by its performance as the world's most competitive economy throughout much of the 1990's and into the 21st century.[1]

The beginning of the 21st century is confronting US industry with a new crisis brought on by a prolonged economic slowdown, steep decline in business investment, a weakened stock market, global economic downturn, and sharpened competition from low-wage countries, especially China. That competition is creating a surging trade deficit—now costing the US well above *$1 billion per day (see Fig. 1 below)*—that simply can no longer be ignored. A softening dollar is now providing temporary relief for exporters, but only a robust, highly competitive manufacturing sector, combined with effective trade policies, can substantially reverse this trend over the long term.

Figure 1. Ballooning Trade Deficit
The goods deficit stood at $427 billion in 2001 increased to $484 billion in 2002 and is on track to hit $550 billion in 2003. Moreover, the level of goods imports is projected to exceed $1.2 trillion in 2003.
Source: Bureau of Economic Analysis

The manufacturing sector in the US has been particularly hard hit by these macroeconomic forces, experiencing 32 consecutive months of job loss totaling roughly 2.3 million jobs, fully 90% of the total jobs lost in the period. In fact, the recent recession might have been appropriately termed a manufacturing one since the economic dislocation fell disproportionately on its shoulders. While recent economic indicators are mildly positive, the current post-recession manufacturing recovery is the weakest on record. The manufacturing sector remains fragile.

This paper explains why the manufacturing crisis is so fateful for the US economy. It also notes how transformational industrial capabilities can create a pathway to sustaining the productivity boom that has persisted even during the current economic slump and leading the nation to a brighter economic future.

The paper then suggests a public policy strategy that can help accelerate this transformation, with enormous benefits for both economic and national security. This strategy can aid industry's effort to respond to the current crisis just as effectively as it did to the competitiveness crisis of the 1980's.

[1] World Economic Forum: Global Competitiveness Rankings

The Vital Importance of Manufacturing

Restoring the manufacturing sector to health is key to the future prosperity of our nation. Despite the job loss, manufacturing still employs 16.5 million people and, due to the multiplier effect, supports at least 3 additional jobs for each manufacturing one elsewhere in the economy.[2] Moreover, manufacturing:

- Contributes roughly 17% of our nation's GDP, and adds 29% to our national output
- Provides 71% of our exports
- Funds 67% of total national R&D, a figure that rises to 75% when industrial research performed under government contracts is included[3]
- Is a major customer for information and communications technologies, signaling that manufacturing and information service industries are actually fusing.

Most importantly, manufacturing is the prime source of productivity growth, setting the pace in the 1990's and achieving high levels of productivity even during the present downturn. Productivity growth is the economic magic that allows the economy to increase its economic "speed limit," growing with low rates of inflation and rising real wages.

Manufacturing also plays a prominent, yet often overlooked, role in our national security. Given the intimate link between the war-fighter and logistics, the Pentagon's commitment to transforming military strategy and weapons systems requires a parallel commitment to transforming the defense industrial base. In the field of homeland security, our ability to provide transportation hubs, first-responders and ordinary citizens with new terrorism-fighting products and technologies on a nationwide scale is critical.

The Vision: Industrial Transformation

Manufacturing has the potential to take a great leap forward in being able to provide the products we want or need, when we want them and at an affordable price. There are various technologies currently in various stages of development that can dramatically alter the way products are designed and made. These include, for example:

- *Reconfigurable Software Tools and Systems* – Single tools or machines that can perform multiple functions including functions not anticipated in the original design and without requiring new tool production.
- *Solid Free Form Fabrication* – The rapid creation of solid objects through the deposition of raw material in a controlled, systematic fashion.
- *Advanced Sensors* – devices that respond to external stimuli and feed that data into larger monitoring, diagnostic and actuation systems.
- *Micro-fabrication* – The creation of materials and parts through the manipulation of matter at the molecular level.

[2]For recent data on this multiplier effect, see the Millken Institute's report, "Manufacturing Matters: California's Performance and Prospects." (2002).
[3] National Science Foundation data, 2001

- *Modeling, Simulation and Visualization* – Using high-speed computers, the ability to build virtual representations of parts, processes and systems, simulate their interaction with one another and their environment and observe that process in a way that is useful.
- *Smart Systems* – Computer-integrated, electro-mechanical systems and processes that have the capacity to *learn.*
- *Designer Materials* – For example, an airfoil that responds to airflow by changing shape or a synthetic material that mimics that which occurs in nature.[4]

As an early step towards transformation, technologies and processes are already in the pipeline to manufacture a "product of one." Also known as "mass customization," this would mean the production of highly individualized products on a mass scale. If combined with low cost and high quality, the benefits of the widespread adoption of this capability would be pronounced.

For many industries, mass customization would mean a shift in traditional thinking from one of supply "push" (build it and they will come) to one of demand "pull" (build it because the customer ordered it). Customers would be able to order products according to their own specifications and have them delivered or be able to pick them up in a relatively short period of time. In layman's terms, such a migration would amount to a "Dell" model applied across the economy. It would thus be a win-win development: companies can reduce inventory and work in process and customers get the products they want, as and when they want them.

If manufacturers across the nation accelerate the development and use of advanced production technologies to transform the means of production, this would profoundly enhance the productivity and global competitiveness of U.S.-based manufacturing. Realizing this vision across the economy would result in substantial economic and societal benefits. However, the widespread adoption of productivity-enhancing technologies within all tiers and sectors of industry will not occur in a vacuum.

The Structural Challenges

The challenge is to ensure that the technologies and processes to enable this transformation are more rapidly developed and deployed. Only when the use of these advanced technologies reach critical mass will they have the desired macroeconomic benefits.

To adopt transformational technologies and related processes, however, US-based manufacturers need to deal with several structural challenges:

Declining rates of capital investment – In response to the economic slowdown and global uncertainties, most companies have been sluggish in investing in the new technologies required to drive transformational change.

Insufficient R&D investment in manufacturing process technologies – Although technology-based productivity growth is enabling the non-inflationary economic growth, funding for basic and applied R&D for productivity-enhancing technologies is scarce within both government and industry.[5] In addition, the relative long lead times for basic and applied

[4] For further details, see "Potentially Disruptive Advanced Manufacturing Technologies," NACFAM, 2003
[5] See, "Federal Support for Manufacturing Science & Technology," May 2001, NACFAM

research need to be compressed, if government-funded research in the field of manufacturing process technologies R&D is to play a significant role in industrial transformation.

A deepening skills gap - Although rapid technological change is requiring new kinds of skills, the skills gap is growing. Nearly 60% of the new jobs in the early 21st Century will require skills that are held by just 20% of the present workforce. Responses to this skills crisis at both federal and state levels remain inadequate.[6] The skills gap is a critical issue, because greater labor productivity will be essential if the US is going to compete successfully with low-wage countries, such as China. (See Figure 2)

Figure 2: The China Challenge

Today, the greatest competitiveness threat to US-based manufacturing comes from low-wage countries, particularly China. China benefits from a surplus of well-educated cheap labor (According to UN estimates China's average wages are 1/3 of Mexico's, 1/5 of Malaysia's and Taiwan's, 1/10 of Singapore's, and 1/20 of U.S. wages). It is not surprising then that Chinese manufacturing has come to dominate labor-intensive industries such as toys, shoes, clothes etc.

What is surprising is that the wealth generated from these activities has created little to reverse the goods trade deficit. There are two significant contributing factors, among others. First, China's economy, and other developing economies in Asia, is deliberately structured to favor exports, the vast majority of which are bound for the Unites States. Competitive regional devaluations, or simply fixed currency regimes pegged at artificially low rates in the case in China, keep the exports flowing.

The second factor is that the labor surplus is of such a magnitude that, although China has seen astounding growth in recent years for an economy its size, real wages have been *falling*. The Chinese economy is simply not creating enough jobs for the masses who want them.

This is significant because economic theory suggests that wage differentials should reflect differences in productivity levels and that any misalignments among countries correct themselves over time. This was true of Japan, the Asian Tigers and even Europe after World War II. The concern is that in the case of China, the adjustment process will be painfully long.

Sources: BCA Research, *The Economist*, MarketWatch, Morgan Stanley

If US-based manufacturers aggressively use advanced technologies and higher skills to substantially reduce labor costs, they will be able to compete successfully with low-wage countries.[7] This process will substitute higher-skill/higher-wage jobs for lower-skills/lower-wage jobs. It will also lead to an overall increase in jobs for several reasons:

- More productive and competitive companies will gain markets, enabling them to expand their businesses and create new jobs

[6]For details on the growing skills gap, see "The Case for Enhancing American Workforce Skills," April 2003, NACFAM, Washington DC

[7] According to The Economist, the labor cost factor has already declined from 30% of total costs in 1960 to roughly 12-15% today.

- Expanded use of advanced technologies will create more jobs in service sectors (systems integrators, computer technicians, engineers, designers, software developers, etc.) directly related to advanced manufacturing.

Supply chain vulnerabilities and weaknesses – Secure lines of supply are needed for both industrial efficiency and national security reasons. Terrorism has increased the vulnerability of supply lines from abroad. U.S.-based suppliers are competing on the front lines with the realities of global procurement.

Lack of a High-level Focal Point for Manufacturing Productivity – Although the areas cited above—incentives for capital investment, manufacturing sciences R&D, workforce skills development, reliable suppliers—are central to manufacturing productivity and competitiveness, these are areas of systemic under-investment at the federal level. This is partly due to the reality that there is no focal point within the Executive Branch for examining these various issues in an integrated, strategic manner.

A high-level advocate for manufacturing is needed within the Administration. Greater attention to manufacturing from senior levels of government will also help stimulate an increase in public-private collaboration, an effective means for mobilizing the nation's resources and creating a more supportive infrastructure for industrial transformation.

The Response: A National Strategy

To consider public policy directions that might address these structural challenges, NACFAM held an "Advanced Manufacturing Policy Planning Session," hosted by GM at its new Tech Center in Warren MI, on March 26, 2003. Nearly 100 executives attended, representing 44 companies and 26 other organizations in both the private and public sectors who are working on the front lines to increase manufacturing productivity.

Statements at this meeting from companies dealing successfully with the competitiveness challenge from low-wage countries supported the view that the U.S. could compete effectively, if industry and government build a strategy based around two basic goals:

1. Increase labor productivity by greatly accelerating the use of advanced technologies.

2. Leverage national resources through a major expansion of public-private partnerships.

In this connection, the group developed forceful policy recommendations, including those cited below.

Move global competitiveness higher on the national agenda:

- A sustained, stronger focus on manufacturing productivity across the highest levels of the Administration, including the Secretary of Commerce, the President's Advisor on Science and Technology, and the President's Council of Advisors on Science and Technology Policy.
- More effective use of the manufacturing-related programs at the National Institute of Standards and Technology given its unique responsibility for assisting industry.

- Use "Save $1 Billion a Day" as a galvanizing goal for reducing the trade deficit as a measure of America's ability to compete.
- Accelerate depreciation of investments in new hardware & software for all manufacturers.

Develop and deploy next generation process technologies: "A New Tool Kit":

- Substantially increase federal investment in productivity-enhancing manufacturing science & technology research.
- Utilize "industry-led, government-enabled" consortia models akin to Sematech.
- Move research more rapidly towards practical application through the concept of "R&I" (Research and Implementation) rather than "R&D."

Enable America's workers to keep pace with technological change:

- Provide a tax incentive for technical re-training over a worker's career.
- Integrate academic and technical/applied learning into the Perkins Act authorization.
- Integrate industry-led skill standards into education and training programs under Workforce Investment Act reauthorization.
- Accelerate development of skills standards-based certification systems.

Decrease supply chain vulnerability and support the nation's smaller suppliers:

- Avoid trade disruptions and maintain secure logistics & supply networks.
- "Hedge" critical military and homeland security products through a strong domestic supplier base.
- Build much higher levels of cooperation and collaboration between Manufacturing Extension Partnership (MEP) services and the supply chain optimization programs of large manufacturers at the sub-tiers.
- Fund the Enterprise Integration Bill for greater standards interoperability and improve IT capabilities of suppliers.

Taking such steps would accelerate the rate of manufacturing innovation, stimulate investment in the most advanced manufacturing equipment, continually improve workforce skills and create a voice in the federal government to ensure the continuation of manufacturing-friendly public policies. The overarching effect of implementing these recommendations would be the reduction of unit labor costs made possible by high rates of productivity growth. Taking the above steps would help industry respond to current competitiveness challenges as effectively as they did to the earlier challenges of the 1980's. In response to the challenges facing manufacturing today this strategy would promise multiple benefits for both industry and the nation.

The Benefits

Striving for and building a future for advanced manufacturing in the United States requires a firm commitment, but would reap many rewards including:

- Sustained levels of productivity growth and wealth creation
- Increased revenues to reduce the federal deficit while meeting a growing range of both domestic and national security requirements
- Higher real wages, leading to improved standards of living for all Americans
- More highly skilled, well paying jobs, both in manufacturing and in the expanding service industries that directly support manufacturing
- Enhanced quality of life through increased consumer choice, higher product quality, and technical solutions to human problems (cleaner environment, improved safety, physical security).
- A corresponding increase in global living standards as technical advancements travel across borders, strengthening domestic markets and providing the political and economic stability that can, and often does, follow.
- A reduction in the alarmingly high trade deficit in goods. As U.S.-based manufacturers increase the flow of products that are fully competitive on the basis of cost, quality, delivery and customization, the incentive for consumers to buy imported goods will decline.

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Chairman EHLERS. And thank you.
Mr. Dunwell.

STATEMENT OF MR. JAY R. DUNWELL, PRESIDENT, WOLVERINE COIL SPRING

Mr. DUNWELL. Good morning, Mr. Chairman, and Members of the Subcommittee. I am Jay Dunwell, President of Wolverine Coil Spring Company located in Grand Rapids, Michigan.

Wolverine Coil Spring is a 57-year-old, third-generation, family-owned business employing over 50 highly skilled individuals in the design and manufacturing of custom metal fabricated products. Besides my role with Wolverine, I also serve as the vice-chair of the Manufacturers Council, an active network of 35 manufacturers in the Grand Rapids area, who volunteer their time to organize and lead the advancement of the manufacturing industry. The Council is supported and organized by the MEP and its Michigan Manufacturing Technology Center and the Local Office, The Right Place, Inc. The Council published a 100-page paper in 2002 entitled, "A Growth and Innovation Agenda for Manufacturing", which can be found on the web at the address noted in my statement. I have brought copies of the executive briefing of this paper, much smaller, and I request that the Subcommittee enter this executive briefing into the record of this hearing.

My statements today will reflect two perspectives: first, my personal experiences; and secondly, the recommendations of the Manufacturers Council.

Our competitive situation: Wolverine follows a business model of operational excellence and customer intimacy. Wolverine does not pursue a product leadership position typical of many larger manufacturers. The products we manufacture are the components or subassemblies of larger products.

The focus for the past decade of many operationally excellent companies has been to continuously improve our manufacturing processes and techniques to eliminate waste, reduce scrap and inventories, and to strive to be the low-cost producer. As a second and third-tier automotive supplier, Wolverine is constantly under pressure to reduce prices. Annual price givebacks, Internet auctions, and market tests are becoming regular events. In some cases, Wolverine has told our customers to move the business, because we can not compete below certain price levels.

Wolverine also incorporates into our mission statement that we must evolve as our customers' needs evolve. If new products or new capabilities are needed, Wolverine realizes that we must evolve to meet those changing needs or jeopardize our close relationships and customer base.

The most significant serious challenge facing our business is customer migration to Asia. According to Industry Week, foreign companies invested $52 billion into China in 2002. I don't know how many jobs each billion dollars of investment equates to, but my fear is that it represents significant loss of American jobs.

One of our customers, a pump manufacturer, requested Wolverine's design assistance. Unfortunately, from the outset, the pump manufacturer had plans to produce this pump in Asia and only needed Wolverine for the design and prototype phase. We were

asked to charge accordingly for our engineering services but not to anticipate any production runs. This is a particularly disturbing example. If more of our customers move their production overseas and only require Wolverine's design assistance, our business model will evolve dramatically: more engineers and dozens less manufacturing setup technicians and machine operators.

Technology plays an important role in Wolverine's business model. New CNC manufacturing equipment reduces setup times, provides more value-added capabilities, and increases pieces produced per hour. Wolverine has implemented in-process sensors and vision systems to ensure zero defects in a world striving for quality levels measured now in rejected parts per billion.

Technology helps make communication with customers and suppliers more efficient every day. Through Internet-based websites, Wolverine can manage our customers' inventory with real-time access to their production plant operations.

Although technology improves operational excellence, operational excellence is not enough. Innovative breakthroughs and process technologies or how we manufacture parts will not make a difference if larger product-leadership companies migrate either their supply base or their assembly operations overseas.

Although many small manufacturers face different challenges than their larger partners in manufacturing, together we face the common threat of remaining competitive in the United States. Typically, small manufacturing issues include price strategy, being the low-cost producer, even return on investment. Plante and Moran reported that many small manufacturers in the automotive supply chain are not making enough return on their investment to continue support of levels of that investment.

Larger manufacturers often have international operations, and I assume, struggle with what new products to introduce and in which of their plants around the globe to produce them. I am not a trade expert, but when U.S. steel tariffs make it less expensive for my customers to manufacture outside the U.S. and import a finished assembly, Wolverine has lost another opportunity.

MEP supports Wolverine in numerous ways around shared learning and peer-to-peer networking, most of which Wolverine has been very involved with. Examples include user groups, workshops, sunrise breakfast series, tours of best practices, economic development, and of course, workforce development.

Building close relationships with dozens of other manufacturers has been the most important aspect of MEP's support. Often I will call another company to discuss an issue and be granted plant tours or, "Come and see how we did it," experiences. Some of my long-term employees have seen for themselves how some challenges can be met can be extremely helpful in making organizational improvements.

The MEP's efforts to improve the manufacturing environment in our region and our country are extremely valuable. Their support has led to competitive improvements and reduced setup times, smaller inventories, shorter lead-times, and improved quality. Funding for such a valuable program should not be reduced, rather increased.

Trade policies, tax incentives, healthcare, and other insurance costs are all examples of issues I feel are beyond the focus of MEP's support of small and medium-sized manufacturers. Issues of this scope require a national economic strategy. The position paper makes specific strategic suggestions. This paper is not about subsidies or handouts. We do want federal, state, and local support for an innovative infrastructure. The paper makes it very clear that operational excellence will not sustain the manufacturing base in the U.S., rather we must reevaluate our position and pursue a national economic strategy that will ensure that innovative and high value-added manufacturing remains the purview of U.S. manufacturing firms.

The paper highlights six recommendations: the appointment of a Secretary or Undersecretary for Manufacturing, increased federal investments in manufacturing-related research and development, expand collaborative research consortia and R&D partnerships, rebuild the dwindling pool of scientists and engineers, and provide economic develop support to manufacturing that is proportionate to its contribution and to the economy, and finally to drive strategies to strengthen regional clusters of innovation.

To conclude, as my comments have highlighted, small manufacturing companies face their own set of challenges in today's changing world. Yet both large and small manufacturers are concerned about the increase in foreign manufacturing and face the very important challenge of building a successful infrastructure to sustain and improve manufacturing here in the U.S. federal support of this innovation infrastructure will assist all manufacturers and the health of the U.S. economy.

Thank you, Mr. Chairman.

[The prepared statement of Mr. Dunwell follows:]

PREPARED STATEMENT OF JAY R. DUNWELL

Introduction

Good morning, Mr. Chairman and Members of the Subcommittee. I am Jay Dunwell, President of Wolverine Coil Spring Company located in Grand Rapids, Michigan. Thank you for inviting me to speak about the challenges facing manufacturing companies and how the Federal Government can help.

Background

Wolverine Coil Spring Company is a third-generation, family-owned business, employing over 50 highly-skilled individuals in the design and manufacturing of custom, metal-fabricated products. We specialize in springs, stampings, wire forms, and assemblies. Founded 57 years ago by my grandfather, Raymond Carlberg, Wolverine supplies products mainly to the automotive and office furniture markets. Wolverine is registered to the ISO and QS–9000 quality standards.

Besides my role with Wolverine, I also serve as the vice-chair of the Manufacturers Council, an active network of thirty-five manufacturers in the Grand Rapids area who volunteer their time to organize and lead the advancement of the manufacturing industry. The Manufacturers Council is supported and organized by the MEP and its Michigan Manufacturing Technology Center (MMTC) and the local office—The Right Place, Inc. The mission of the Manufacturers Council is to promote, facilitate, and enable implementation of "world-class manufacturing" principles and practices among manufacturers. To fulfill this mission, the Council follows three basic strategies:

- Provide a forum for interaction among executives to network
- Articulate and prioritize the needs of area manufacturers
- Improve the preparation of the local workforce and the workforce development systems (I co-chair the workforce development subcommittee)

The Manufacturers Council published a 100-page paper in 2002 entitled: "A Growth and Innovation Agenda for Manufacturing: A Manufacturers Council Position Paper" which can be found on the web at: *www.rightplace.org/Info_Center/library.shtml.* I have brought copies of the Executive Briefing of this paper, and I request that the Subcommittee enter this Executive Briefing into the record of this hearing.

My statements today will reflect two perspectives. First, my personal experiences as the leader of Wolverine Coil Spring Company and the issues facing our small business. Secondly, the recommendations of the Manufacturers Council paper and its broader view of the manufacturing industry.

Competitive Situation

Wolverine follows a business model of operational excellence and customer intimacy. Wolverine does not pursue a product leadership position typical of many larger manufacturers. The parts we manufacture are components or sub-assemblies of larger products.

The focus for the past decade of many operationally excellent companies has been to continuously improve our manufacturing processes and techniques to eliminate waste, reduce scrap and inventories, and to strive to be the low-cost producer. As a second and third-tier automotive supplier, Wolverine is constantly under pressure to reduce prices. Annual price give-backs, Internet auctions, and market tests are becoming regular events. In some cases, Wolverine has told our customers to move the business, because we cannot remain profitable below certain price levels.

Wolverine also competes within a customer intimacy model. Through strong and close customer relationships, Wolverine strives to create customer loyalty. Ken Blanchard, author of "Raving Fans" describes a level of customer service so exemplary that customers rave about their experiences to friends and coworkers. Wolverine pursues this "raving fan" customer satisfaction in our approach to customer service. In fact, our true competitive advantage lies solely in our customer relationships. To support "raving fan" customers, Wolverine provides design and engineering assistance at the start of our customers' projects as well as other services.

Wolverine also incorporates in our mission statement the principle that we ". . .must evolve as our customers' needs evolve." If new products or new capabilities are needed by our customers, Wolverine realizes that we must evolve our product offerings and services to meet those changing needs or jeopardize our close relationships and customer base.

Serious Challenges Facing Our Business

Customer Migration to Asia

According to *Industry Week* magazine's June 2003 issue, foreign companies invested $52 billion into China in 2002. I do not know how many jobs each billion dollars of investment equates to, but my fear is that it represents a significant loss of American jobs. Further, this investment is expected to multiply in the coming years. The migration of manufacturing to Asia, and in particular China, is gaining steam with no end in sight.

One of our customers, a pump manufacturer projecting to make 20,000 units per year of a new pump, requested Wolverine's design assistance. Unfortunately, from the outset, the pump manufacturer had plans to produce this pump in Asia and only needed Wolverine for the design and prototype phase. We were asked to charge accordingly for our engineering services, but not to anticipate any production runs.

This is a particularly disturbing example. If more of our customers move their production overseas and only require Wolverine's design assistance, our business model will evolve dramatically—more engineers and dozens less manufacturing setup technicians and machine operators.

Typically, Wolverine and our competitors do not charge for design assistance, choosing rather to fold the cost into the production tooling or piece price, thereby recouping the cost when the production phase begins. Many customers may not be as forthright with their intentions to source their production quantities overseas as this pump manufacturer was, leaving Wolverine with the difficult customer relationship issue of whether to charge for design services or not.

The pace of this overseas migration is moving like a wildfire. Just last month, an airplane full of office furniture managers toured Asia in search of new supply chain opportunities. Wolverine has been in business for over fifty years, and we will evolve and survive. But will we have only engineers, CAD operators, and prototype production capabilities? As a component manufacturer, the migration of each final assembly to an overseas production line represents one less assembly requiring component pieces. Will a market remain for component manufacturers—typically the small and medium-sized manufacturers?

Attracting Students to Careers in Manufacturing

From my work with the workforce development systems in Kent County, I continue to see an aversion to careers in manufacturing. Parents, counselors, teachers, and administrators often portray careers in manufacturing as they have been portrayed for years—dark, dirty, dangerous, and dead-end. Rather, today's manufacturing often requires highly-skilled individuals to work with the latest in technology in bright, clean work environments. Without a good supply of talented, technically-skilled individuals, the strength of manufacturers will be reduced.

The Role of Technology in Addressing these Challenges

Technology plays an important role in Wolverine's operational excellence and customer intimacy business model. New CNC manufacturing equipment reduces setup times, provides more value-added capabilities, and increases pieces produced per hour. Wolverine has implemented in-process sensors and vision systems to insure zero defects in a world striving for quality levels measured in rejected parts per billion.

Technology helps make communication with customers and suppliers more efficient every day. Through Internet-based web sites, Wolverine can manage our customers' inventory with real-time access to their production plant operations and product demand schedules. Electronic-based financial transactions have replaced the invoicing and accounts receivable paper process of year's past. Engineers work collaboratively with customer and supplier CAD drawings connected via the Internet. Even quality issues can be addressed more quickly and accurately when the digital picture of the problem arrives moments after discovery.

Although technology improves operational excellence, operational excellence is not enough. Innovative breakthroughs in process technologies, or *how* we manufacture parts, will not make a difference if larger, product-leadership companies migrate either their supply base or their assembly operations overseas.

Different Challenges Faced by Small-to-Medium Sized Manufacturers versus Large Manufacturers

Although many small manufacturers face different challenges than their larger partners in manufacturing, together they face the common threat of remaining competitive in the U.S. Typical small manufacturing issues include:

- *Price strategy.* With the economic slowdown and increased migration to foreign soil, many small companies are lowering prices in a desperate attempt to keep their machines running and doors open.
- *Lowest-cost producer.* Small manufacturers are implementing lean manufacturing principles.
- *Return on investment.* Plante and Moran reported that many small manufacturers in the automotive supply chain are not making enough return on investment to continue to support the levels of investment. Consolidation will continue until excess capacity is reduced.

Larger manufacturers often have international operations and I assume struggle with what new products to introduce and in which of their plants around the globe to produce them. I am not a trade expert, but when U.S. steel tariffs make it less expensive for my customers to manufacture outside the U.S. and import a finished assembly, Wolverine has lost another opportunity.

Small companies often struggle with small staff sizes where each individual wears many hats. This organizational structure makes it difficult for small manufacturers to keep informed of important, bigger-picture issues. The MMTC/Right Place has been very helpful in keeping manufacturers, of all sizes, informed of broader issues.

MEP/Michigan Manufacturing Technology Center (MMTC)/The Right Place, Inc. Support

MMTC/Right Place has further supported Wolverine in numerous ways. The Right Place, Inc. organizes many opportunities for shared learning and peer-to-peer networking, most of which Wolverine has been involved with. Examples of MEP support include:

- User Groups—(setup time reduction, lean manufacturing, QS–9000, Family Owned Business)
- Workshops—(strategic planning, working in teams, workplace organization, continuous improvement techniques)
- Sunrise Breakfast Series—(supply chain management, economic forecasting, automotive industry analysis)

- Tours of Best Practices—(plant tours to dozens of manufacturers highlighting a particular best practice)
- Economic Development—(position papers, manufacturing industry policy, renaissance zone, plant renovation)
- Workforce Development—(skills needed in today's manufacturing, work-based learning www.workpaths.com, guaranteed diploma, advisory boards and committees)

Building close relationships with dozens of other manufacturers has been the most important aspect of MEP support for Wolverine. Often I will call another company to discuss an issue and not only have I been greeted with sincere support, but I have often been granted plant tours or "come-and-see-how-we-did-it" experiences. For some of Wolverine's 20-year plus employees, seeing for themselves how some challenges can be met can be extremely helpful in making organizational improvements.

The MEP's efforts to improve the manufacturing environment in our region and our country is extremely valuable. Their support has lead to competitive improvements in reduced setup times, smaller inventories, shorter lead times, and improved quality. Funding for such a valuable program should not be reduced, rather increased.

Problems Beyond the MEP Capabilities and How the Federal or State Government Can Help

Trade policies, tax incentives, health care and other insurance costs are all examples of issues beyond the focus of MEP's support of small and medium-sized manufacturers. Issues of this scope require a national economic strategy. The position paper, "A Growth and Innovation Agenda for Manufacturing," makes specific strategic suggestions.

Let me now turn our focus to the paper and its innovation theme. This paper is *not* about subsidies. We are *not* looking for handouts. We *do* want Federal, State, and local support for an innovation infrastructure. The paper makes it very clear that operational excellence will not sustain the manufacturing base in the U.S. Rather we must reevaluate our position and pursue a national economic strategy that will ensure that innovation and high value-added manufacturing remains the purview of U.S. manufacturing firms.

The paper highlights six recommendations:

1. Increase the visibility and priority of the manufacturing sector within the Federal Government, including the appointment of a Secretary or Undersecretary for Manufacturing.
2. Increase federal investments in manufacturing-related research and development.
3. Expand collaborative research consortia within the private sector, and R&D partnerships between industry and the public sector (via higher education, federal laboratories, and others).
4. Rebuild the dwindling pool of scientists and engineers starting at the K–12 level and including support for undergraduate and graduate training in technical disciplines.
5. Provide economic development support to manufacturing that is proportionate to its contribution to the economy.
6. Drive strategies to strengthen regional clusters of innovation.

Conclusion

As my comments have highlighted, small manufacturing companies face their own set of challenges in today's changing world. Yet both large and small manufacturers are concerned about the increase in foreign manufacturing and face the very important challenge of building a successful infrastructure to sustain and improve manufacturing here in the U.S. Federal support of this innovation infrastructure will assist all manufacturers and the health of the U.S. economy.

Thank you, Mr. Chairman and Members of the Subcommittee, for providing me the opportunity to address you today. I will be happy to answer any questions.

Chairman EHLERS. And thank you, Mr. Dunwell. And let me just mention on the one point you raised, there is a bill in the House currently to create a new position of Undersecretary for Manufacturing in Commerce Department. I think it is badly needed. The Commerce Department has, in a sense, lost its focus on that partly

because 71 percent of their budget goes into science and only 29 percent goes into commerce at this point. We hope that will change.

Mr. Farmer. Microphone.

STATEMENT OF MR. JASON FARMER, DIRECTOR OF ADVANCED TECHNOLOGY, NLIGHT PHOTONICS CORPORATION, ACCOMPANIED BY SCOTT KEENEY, CEO AND PRESIDENT, NLIGHT PHOTONICS CORPORATION

Mr. FARMER. Oh. Mr. Chairman, and Members of the Committee, thank you for having me here today. Today I am here with our CEO and President, Scott Keeney, to talk to you about our experiences with the SBIR program and the company nLight Photonics that that program enabled us to found. The challenges that we face, moving forward, and also outlined our thoughts on how the government can help.

A little bit on my background, I was the principle investigator on, perhaps, a half a dozen SBIR programs that enabled us to move a new technology in high-powered semiconductor lasers from a concept to a real working technology demonstrator, a prototype device. That device enabled us to raise over $55 million to found a new company to manufacture that technology.

High-power semiconductor lasers have many important applications in defense, medical, and industrial markets. In defense markets, those applications are not only crucial today, they are also crucial in the future. Today, high-power semiconductor lasers are used for illuminators, for target designators, and precision-guided weaponry, as well as for night vision equipment. In the future, this technology will also be used in tactical weaponry and advanced systems that will enable us to continue to be leaders.

In the medical arena, there are applications that range from dermatology, actually removing acne, tattoo removal. There are a lot of applications in surgery, therapeutic applications, treating cancer, and many other leading edge applications that will enable new medical applications.

In the industrial markets, these high-power lasers are used for cutting and welding in a wide variety of manufacturing areas.

This technology, high-power semiconductor lasers, was really invented in the United States and first demonstrated in the United States. There was government funding that led to the initial developments in the communications industry that saw such explosive growth in the late '90's, not only to send data, but also to pump fiber amplifiers that continue the data on its transmission, on its path through many thousands of kilometers across the Nation. When that industry imploded recently, all of the big manufacturers in the United States exited that business and have moved overseas. The large competitors in this area today are either headquartered or have—most of them, large parts of their facilities overseas in Europe and Japan.

The current leaders in the United States are largely small businesses. The technology still exists in the United States, but moving forward, there are challenges that these small businesses face. These small businesses, I believe, are largely in that "valley of death" that you described in the hearing introduction. This "valley of death" is about bringing the technology to market and con-

tinuing to improve the technology, maintain U.S. leadership and enable these new applications that will enable the markets for semiconductor—high-powered semiconductor lasers to expand.

The government can execute on a very different strategy than the equity markets can today. The venture capital funding that is available today is focused on very near-term applications and markets. The government is in a different position in the sense that it can execute a more strategic plan. That strategic plan can focus on the right technology for long-term markets that will enable the U.S. to maintain a leadership position in high tech.

Specifically with respect to the SBIR program, I believe that there are two key points. One is improved and external governance for that program. This will not only enable that program to continue to focus on the right technologies for the future, it will also provide the—I am sorry. I lost that thought.

The other key thing that I believe can be helpful in the SBIR program is to improve or increase phase one funding levels. Phase one funding levels today are at such a level, at $70 to $100,000, that it is difficult for companies to execute on and make meaningful progress on a program of that size. Further, at companies that focus on SBIR funding to commercialize technology, they can often wind up with numerous phase one programs that are oftentimes unrelated. That makes it very difficult with a team of people focused on different technologies or having a variety of small programs to execute a focused commercialization strategy for their technologies.

In summary, I think that improving external governance for the SBIR program and continuing to involve and increase the involvement of product centers within the services as well as external, perhaps, commercial boards to review the program as well as improving phase one. And, perhaps, phase two funding levels would go a long way to enhancing the commercialization rates of SBIR technologies.

Thank you.

[The prepared statement of Mr. Farmer follows:]

PREPARED STATEMENT OF JASON FARMER AND SCOTT KEENEY

I. EXECUTIVE SUMMARY

Semiconductor diode lasers are a crucial part of U.S. high tech industry with important applications in defense, industrial, medical and telecom markets. However, the U.S. industry is now threatened due to the current recession in the technology and telecommunications sectors and many of the key companies have either exited the market or moved offshore. Federally funded programs such as the SBIR and the MANTECH programs have had a significant impact on the development of this industry. Increasing the funding in these programs would play a crucial role in this industry during this severe downturn.

II. BACKGROUND ON THE SEMICONDUCTOR LASER INDUSTRY

Technology Overview

Semiconductor lasers are crystalline devices that convert electricity directly into light. Semiconductor laser manufacturing processes are very similar to those used to fabricate semiconductor integrated circuits (ICs), however unlike an IC that manipulates electrons, lasers primarily manipulate photons. This leads to a different set of technology issues that are faced by the laser industry. Because the wavelength of electrons is far smaller than the size of individual transistors within an IC, the key issue driving the electronics industry is size reduction. Photons, on the other hand, have much larger wavelengths and fabricating devices on this size scale can be done with standard semiconductor processing equipment. The key issues in

the semiconductor laser industry surround performance issues such as output power, efficiency of conversion of electrons to photons, and long-term reliability.

Key Markets—Telecom Applications

While there are a wide range of applications for high power semiconductor lasers, semiconductor lasers have received a great deal of publicity as the crucial enabling technology for telecommunications providing the extraordinary expansion in bandwidth in fiber optic systems over the last ten years. These lasers not only send data through fiber optic cables by blinking on and off as many as 10 billion times per second, they are also used to optically pump fiber amplifiers that amplify these signals as they are absorbed and scattered through thousands of kilometers of fiber optic cable. Both of these technologies were largely developed in the U.S. and allowed the explosive growth in this industry; between 1999 to 2000 the whole market grew by nearly 200 percent. Currently this market is in a major recession as this extraordinary expansion in capacity has led to a glut of bandwidth. Over time, this market will again become important as lasers will remain a crucial technology for meeting the ever-increasing demands for data transmission.

Key Markets—Defense Applications

While telecommunication applications have been highly volatile, there are many other applications that are equally important to the U.S. and have continued to experience strong growth. Most recently the defense applications have received significant attention, as semiconductor lasers have been crucial in transforming the modern battlefield. Today semiconductor lasers are used in precision-guided weaponry, target designators, night vision equipment, and counter measure devices to defend aircraft against shoulder fired heat sinking missiles. Without semiconductor lasers, which, as an example provided night time covert illumination for Coalition Forces, recent conflicts in Afghanistan and Iraq would have been very different indeed. In the future, semiconductor lasers will play an ever-increasing role in the military. Perhaps one of the most important new applications for high power semiconductor lasers is in the directed energy weapons arena where they could be used to defend high value assets against missiles and other highly maneuverable threats. To date, semiconductor laser technology has provided our war fighters with vastly superior capabilities on the battlefield. Future improvements in the technology will be crucial to maintain and improve upon this advantage.

Key Markets—Industrial and Medical Applications

Semiconductor lasers are also important in a wide range of commercial applications in both industry and medicine. In industry, semiconductor lasers are one of the fastest growing market segments as they replace other, older technologies currently used in welding, heat treating, and semiconductor processing applications. In medicine, semiconductor lasers are used in a wide range of diagnostic and therapeutic applications in such fields as ophthalmology, cardiology, oncology, and dermatology. Many of these applications will benefit from the cost reductions occur as the manufacturing technologies are improved and production levels increase.

III. CURRENT CRISIS IN THE U.S. SEMICONDUCTOR LASER INDUSTRY

Despite these important applications, the current U.S. semiconductor laser industry is undergoing a severe downturn. While this downturn has been driven in part by a downturn in the general technology sector, the semiconductor laser industry has been hit particularly hard by the unprecedented downturn in the telecommunications sector. As a result most of the major manufacturers in the U.S. have closed down their manufacturing operations and laid off tens of thousands of employees. Two years ago the U.S. had a significant lead over the rest of the world in semiconductor lasers. As a result of the downturn, the biggest semiconductor laser fabrication facilities are now in Europe and Japan while China is beginning to expand into this market.

Although the U.S. still has state-of-the-art technology, most of the semiconductor laser companies in the U.S. are now small businesses struggling to survive.

Changes in U.S. Venture Capital

The U.S. venture capital industry provided the primary source of funding for many new companies that were formed in the last five years. However, the downturn has led to significant changes in venture funding and it is currently extremely difficult to get funding for semiconductor laser engineering and manufacturing improvements—let alone get funding for any new technology developments. As recently as two years ago, venture capitalists were more focused on distinctive technology that could dominate a large market, whereas today they are more focused on investing in companies with current sales in near term markets. This has created

a "valley of death" for many small companies that can't bridge the chasm between new technology prototypes and products ready to enter commercial markets. In particular, the funding for optical components (including semiconductor lasers) has all but disappeared relative to the investments of just two years ago.

IV. POTENTIAL AREAS OF SUPPORT FROM FEDERAL GOVERNMENT

Over the past thirty years the semiconductor laser industry has received funding for critical technologies from a wide range of Federal Government programs—including SBIR, MANTECH, and ATP. This has enabled the U.S. to lead not only in defense applications of semiconductor lasers but also in many commercial applications. As venture capital funding has diminished, continued federal support is crucial to maintain a strong competitive advantage. Indeed, with a few focused and effective investments through programs such as these, the Federal Government can play a significant role in strengthening this and other key industries within the U.S.

SBIR Program Example

The SBIR Program was established by the Small Business Innovation Development Act of 1982. It invests over $1.3 billion dollars a year in a wide range of technologies through ten government departments and agencies. This early stage funding for new concepts and technologies, is an important example of how the government can impact small businesses competing in high tech markets. While this program has been highly effective in commercializing numerous technologies continuing to improve the governance and increasing the flexibility in funding levels will make this program even more successful.

1. Governance

As with any successful technology development program, it is vital to have a strong governance system that ensures the technology meets or exceeds the requirements of the end application. Recently, governance of the SBIR program has been significantly improved by increasing the involvement of product centers within the services. Such efforts need to be continued and increased to ensure successful commercialization. Historically, without such governance, many small businesses with SBIR funding have become merely extensions of the research labs supporting them and thus not fulfilling the commercialization objectives of the SBIR program. A focused strategy to improve governance across the SBIR program will enhance the productization rate of SBIR technologies.

2. Increased Award Levels

Increasing the size and reducing the number of individual awards would dramatically improve the commercialization SBIR technologies. The SBIR program plays a critical role helping small businesses to commercialize new and innovative technologies. With the current lack of venture funding and other investors, the SBIR program is more important now than it ever has been.

Increasing the funding level of Phase I efforts to $300 to $500k would enable small businesses to produce a meaningful result and to execute a focused commercialization strategy. The typical funding level for a Phase I SBIR program is between $70k and $100k, sufficient to support one full time technical employee for three to five months. With such limited funding it is challenging to produce a meaningful result. Further, a company that targets SBIR funding to develop new technology inevitably wins numerous Phase I awards that are often unrelated. Managing many small and disjointed technology development programs makes it exceptionally difficult to execute a focused commercialization strategy.

Phase II SBIR programs are typically funded at just under $750k and support one and a half to two full time technical employees. While this level of funding is often sufficient to produce a device that demonstrates key aspects of the new technology, there are many cases where it is insufficient. In these cases, a "bucket of parts" is delivered with a final report and the investment is lost. Increasing the flexibility of Phase II funding levels would alleviate this issue.

At the conclusion of a successful Phase II, the technology is at the edge of the "valley of death." Turning the new technology into a product requires a sustained engineering effort that goes beyond the scope of a Phase II. Increasing the involvement of entities capable of providing Phase III funding is critical to keeping these new technologies from languishing in the valley of death.

V. SUMMARY

SBIR, MANTECH, ATP, and other technology programs have shown a high return on investment, especially in the area of lasers and electro optics. Recently, significant U.S. semiconductor laser capacity has been shut down and the competitiveness of the U.S. industry has diminished. However, crucial capabilities still reside in a

number of smaller firms. Increased flexibility in Phase I and Phase II funding levels and a concomitant focus on effective governance would produce much higher commercialization rates of SBIR technology. Further, bringing a new technology to market requires funding levels that exceed that of the SBIR program. With higher their funding levels, the MANTECH and ATP Programs as well as agencies with Phase III SBIR funding, will play a crucial role in revitalizing the U.S. semiconductor laser and other vital industries and ensure that U.S. technology continues to be competitive.

VI. BACKGROUND ON NLIGHT PHOTONICS

nLight Photonics was founded in 2000 to commercialize novel high power semiconductor laser technology that was originally developed on several small SBIR programs. nLight has raised over $55 million from premier U.S. venture capital firms and has established a world-class diode laser fabrication facility in Vancouver, WA. After the downturn in the telecommunications industry, nLight successfully leveraged its high power semiconductor laser technology to enter medical, industrial and defense markets. nLight Photonics is representative of the small businesses that are trying to maintain and improve this critical technology within the U.S. Unlike larger businesses that ceased U.S. operations and a plethora of the other small businesses that continued to focus on the telecommunications industry and were subsequently shut down, nLight and a few others have survived by refocusing their technologies on important new applications.

DISCUSSION

ISSUES IN INTERNATIONAL COMPETITION

Chairman EHLERS. Thank you. And thank you to all of the witnesses for your testimony. Thank you, also, for abbreviating your statements. And without objection, all of your complete statements will be entered into the record.

The—I have a host of things I could ask questions about. Let me make a few comments. First of all, Mr. Eagar, I totally agree with you that the greatest need is education. And I have spent a good share of the last—of my entire life working on this problem, but particularly the last five years of my political life trying to improve math, science, engineering, and technology education in the K–12 system, where I think the greatest need is. I see things starting to turn around. Certainly, I have been able to get greater funding in for teacher training in those areas, but it is a major national problem, and that has to continue. So I appreciate your emphasis on that.

I especially appreciate your emphasis on the—that learning is a lifelong process. As you might expect, I get asked to make a lot of commencement addresses, and I generally include a statement along the line that this diploma you have received is not a union card. It is a learners' permit. And I think we really have to view that into our students. But the purpose of education is to learn how to learn and to learn how to think. It is not to acquire a body of knowledge and say, "Okay. That is it." I—and so I really appreciate your emphasis on that.

Mr. Reininga, on your one comment you made about an opportunity to analyze all of these different aspects that are troubling to American business, but the one you raised about difficulty to compete with other nations because of subsidies, I assume you mean primarily the European nations, in this case. I have heard this a great deal about Airbus versus Boeing, but I haven't—I hadn't realized that this was carrying over into the avionics field as well. Can you expand on that a bit? What subsidies are you re-

ferring to, and to what extent do you believe they might violate the current free trade laws that we have?

Mr. REININGA. I can not tell you whether they violate any laws or not. That I can not tell you, but I can tell you that what I am referring to is the heads-up display that Airbus currently put in—just procured. And they competed against one of our companies, called Kaiser Electronics—I am sorry, Flight Dynamics. And obviously, we have pretty much cornered that market up to this point, about 95 percent of it. Tallus has very little, if any, production in that and design capabilities. And they received a sizable offset with the French government to go build that capability and therefore won the program. It was pretty much out in the open and told us that is what happened.

Chairman EHLERS. That is interesting. That is a useful example for us to keep in mind. That argument continues with the French. It is one of several that we have with them.

TRANSFORMING RESEARCH INTO DEVELOPMENT

The—I forget which one of you made the comment. Something to the effect that the U.S. does a good job of developing new products, but doesn't always follow through with the manufacture. And I have heard that many times. I wonder if any of you could elaborate on that and put some meat on those bones for me.

Mr. RHOADES. There is, indeed, a long distance between the creation of a new idea and the implementation of that, particularly in manufacturing, because manufacturing, as an activity, is very complex, as many components, each of which having dozens of manufacturing operations to make it, that all have to converge and come together to have a final product. So there is a lot of resistance and—resistance to change, so the implementation of new ideas into—and to actually fabricate them and make them is a long step. That—there is more science in the world today, far more science, than there are organizations that are capable of transforming them into new tools that people can use to make things.

And that is the infrastructure that, in my remarks, I felt was a very vibrant opportunity for investment on behalf of the U.S. taxpayer. Building that infrastructure would enable the accelerated transformation of a new idea in a science level into a practical product and manufacturing method that would build economic value for the Nation.

ENGINEERING DEGREES AND EMPLOYMENT

Chairman EHLERS. Let me tie that in with Mr. Eagar's comments earlier, and maybe you can discuss that. I have an interesting graph, which shows the number of baccalaureate degrees given in engineering over the past 20 years. And it peaked about 17 years ago and has been going down ever since. The graduate degrees have gone up, primarily due to the influx of foreign students. But is part of the problem that we are just not getting enough engineers, we are not getting bright enough engineers, or is it strictly moderate a problem that our wage rates are so much higher than other countries that it is difficult to put those together? Mr. Eagar.

Mr. EAGAR. If I might address that, I believe there is a structural problem that we have. You are right; we don't produce as many engineers on a per capita basis. China produces two and a half times as many engineers, graduates, per year as we do. And on an absolute basis, since they are larger, they produce about ten times as many engineers as we do. And that investment that they are making is going to pay off in the future.

ADDRESSING THE "VALLEY OF DEATH" ISSUE

We are investing quite a bit in research, which I define as something that has some future payback more than 20 years. Companies invest, today, in the—up to five years out. If you just look at the profitability of the companies, very few companies, except the ones that are sort of semi-monopolistic, can not afford to go look more than about five years out. The "valley of death" that people are talking about, and I think you have heard it from three or four of the panelists here, is the 5- to 20-year horizon. Now the military has 6–1, 6–2 monies for exploratory—6–2 is for exploratory development. And when I talked about balance, that is what I was talking about. They actually spend roughly the same amount of money on development as they do on research, which I think is actually—when he is saying "bringing it to market", that is what I am calling "development". That is the 5- to 20-year time frame.

To give you an example, about 5 to 10 years ago, a Japanese scientist invented Gallium nitride, the blue laser, and this goes to Mr. Farmer's, you know, exciting developments in the science of laser technology. Well, a lot of people didn't realize that what a blue laser allows you to do is to make white light. And so there are a few companies now that—this thing—this technology has been around for about 10 years, and some time about 10 to 15 years from now, you are going to see panels that will just be panels of light that will give you new architectural possibilities. Not only that, it reduces the electricity required by ⅔. And given the fact that about 30 percent of the electricity we consume in this country is for lighting, you are talking about a 20 percent reduction in the electricity generating capacity, which is going to have wonderful effects on the environment. It is not going to be so great for some of the people that make generators, but you know, there are going to be displacements because of the new technology.

Who is funding that? Who is going to take the risk? There are a few companies taking that risk, because the payoff is so huge, but we have lots of technologies that don't have tens of billions of dollars of payoff. The ones that have less payoff are the ones that are dying. We have done the research, and we are squandering the research investment by not doing the development in the 5- to 20-year horizon.

Chairman EHLERS. Thank you for that summary. My time has expired. Let me just observe that in the Energy Bill, which the House just passed, we did specifically allocate funding for that—new sources of lighting. But your point is well taken. There is not enough there, and it is going to be too much of basic research and very little on the developmental aspects.

My time is more than expired. I am pleased to recognize the Ranking Member, Mr. Udall.

Mr. UDALL. Thank you, Mr. Chairman. Again, I want to thank the panel. Your testimony has been very interesting and helpful.

THE ROLE OF ATP IN PRODUCT DEVELOPMENT

I am drawn to Mr. Farmer for a couple of reasons. He is a graduate of the big research university in my District, the University of Colorado in Boulder. And Chairman Ehlers spent a year at Jilla, which is a consortium attached to the University of Colorado, but it also has a relationship with some of the federal labs in the private sector.

We also in Colorado have close to 300 companies involved in photonics. And we have a vibrant set of efforts underway there in this whole exciting area.

I had just a couple questions for you. I hear you say that the ATP would be a great help to small high-tech companies like yours. And there are some in the Congress and the Administration that actually make the case that ATP is nothing more than corporate welfare. Could you respond to that point of view?

Mr. FARMER. In my view, the ATP program, like the other programs with higher levels of funding, are critical to moving technologies from product demonstrators like what we built on the SBIR program and like what is enabled by a phase one and phase two SBIR program and really amplifying that and bringing it to market. I believe that many companies today, you know, while their thinking may go out five years, don't have the funding to actually fund a manufacturing line and to bring the technology to the point where it is ready to enter a commercial market. And the ATP program, I think there is probably numerous examples where the ATP program has supported the sort of engineering that is needed to put into technology to really make it commercializable.

Mr. UDALL. Yeah, I hear both you and Mr. Eagar and perhaps other members of the panel suggesting that, in a sense, ATP, SBIR, and some other programs serve as long-term capital——

Mr. FARMER. Um-hum.

Mr. UDALL [continuing]. That the equity markets are more focused, the private equity markets are more focused on short-term returns, and that this is the important role that the Federal Government's monies play. And I think we need to do a better job of explaining that to the average citizen as well as to other interested parties and to Members of the Administration, Members of the Congress. Would you agree?

Mr. FARMER. I would absolutely agree. I think it is actually even more critical today than it ever has been in the past. In the past, there was equity funding that could take those technologies from the prototype phase to the commercialization, the point where you have actually entered a commercial market. I think that nLight is an example of that. We—on, you know, probably under $2 million, developed a commercial—or a technology prototype and then were able to go and raise equity capital to cross that "valley of death". And that is—that equity capital is not there today, and so the role of ATP programs and ManTech programs, I think, is of heightened importance today.

Mr. RHOADES. If I may respond to that for a moment.

Mr. UDALL. Sure.

Mr. RHOADES. My company has received an ATP program to support the development of a process invented at MIT that is capable of manufacturing functional metal parts with an entirely new method that digitally assembles particles of metal to make functional parts with very complex geometries that enables the ability to make designs directly from a CAD file and could transform manufacturing into a methodology that is appropriate for the U.S. with little labor that can make parts locally, rather than halfway around the world. So the difference that the ATP effort made in taking a science from a university and transforming it into a way that now makes parts commercially for people that walk up and send us a design. We can make them a part for so much per pound of any complexity they choose that is just as functional as conventionally made metal parts. That transformation is precisely what ATP has enabled and I think really offers an example of how taxpayer—U.S. taxpayer investment can have a very high payoff, ultimately for the U.S. taxpayer, because this is a process that is appropriate to the United States much more so than appropriate to a low labor cost country in an emerging industrial nation.

Mr. UDALL. That you are saying, Mr. Rhoades, is it works to our advantage, works to our strengths in this higher tech society and environment in which we find ourselves? It takes advantage of that platform off which we are operating?

Mr. RHOADES. Exactly.

Mr. UDALL. I appreciate the panel's presence here today, and hope we get another round of questions, because I didn't even get into half of the questions I have. Thank you.

Chairman EHLERS. The gentleman's time has expired. Next we turn to the Congresswoman from Illinois, Mrs. Biggert.

DEVELOPING A HIGH-TECH MANUFACTURING WORKFORCE

Mrs. BIGGERT. Thank you, Mr. Chairman. And thank you for all of that information. I think this is an issue that has been so important to the Congress and has—really gaining in the discussions, like in the small businesses and the financial services and the Science Committee. So it is great to have you here.

I was in China earlier this year, fortunately before the SARS. But we were there on really national security, but also trade involving—certainly manufacturing is a very important part of that. And looking at the economic base for the Chinese for their income, average income per year is 900 U.S. dollars, I believe, and so they obviously are a very labor-intensive country, who can get into manufacturing for those kinds of products. And certainly, we would like to increase our exports to China, but we really don't have the money to purchase the kind of exports that we can send to them, because they have all of the products that don't cost that much to produce. So it is amazing to see, you know, how they have become a real, what I would say, a capitalist country and are growing and growing and really have a long-term plan in how they are going to do this. Now they have had a setback, I guess, with—right now.

But—and the other thing is that they want our high-tech so that they can begin to do that, too, which is where we really have an advantage there. How can we continue with innovation and I think what you all mention is that we need to have the innovation to pro-

vide the new products, because the things that we used to be able to do, other countries are doing and at less cost. How can we increase the innovation and yet keep ahead of the other countries, taking—now you know with the CDs and things, they say, "Oh, no, we don't copy those. There is no intellectual property that we take over." And yet you can go two blocks away from the hotel and find those on sale before they even are out in the United States. Do you have how we develop—you know, you have talked a lot about education, which I think is so important. And how we—but how do we actually move our workers from those industries and get them into the high-tech industries where we are also decreasing the number of workers that we need because of the high-tech capabilities that we have? Mr. Eagar, you——

LIFELONG WORKFORCE EDUCATION

Mr. EAGAR. Well, one thing on the—I believe some companies pay for knowledge. And I would hope that as the minimum wage goes up, maybe we would consider paying for literacy and numeracy in the workforce. You have got to incentivize the worker to go to the lifelong education. It is much easier, you know—it is difficult to continue your education while you are a full-time worker. And there has got to be some incentive. There has got to be some incentive to the companies to do this. Right now, a company that has an active educational program for their workforce is basically paying an extra tax voluntarily. If everyone is doing it, no one—everyone is paying a fair share, so there has got to be some incentive for the companies. There has got to be some incentive for the worker to learn to read and write if they don't know how.

And we can't just do K through 12. It is important to do K through 12, but we need a literate workforce now, not just 20 years from now. So we have got to look at it from that. So maybe the minimum wage is a sliding scale depending on your literacy and your numeracy. And you are paying people—you are incentivizing the people at the bottom end of the workforce pay scale to go out and improve themselves. The people at the top end are going to do it anyway. They have already done it. They have already invested in education, and many of them continue to do it. It is the bottom end of the workforce that we have got to help.

SUCCESSFUL COMPETITION AGAINST LOW-COST LABOR

Mr. REININGA. If you look at the avionics industry, our industry, less than three percent of the cost of our product is labor. So—and Boeing and Airbus together are only going to make about 400 aircraft, so mass production and highly automated activities are very important to us, but only from a reliability and technology standpoint. So from our standpoint, if we can get mass customization using the latest technology, we can compete, even with their low labor cost, because the—we just need to be able to support our technology. And it will be far past where they are coming up at it.

Mrs. BIGGERT. Yes.

Mr. FARMER. I would amplify on that saying that the way that we can compete against low-cost labor is with advanced manufacturing technologies like the ones that Mr. Rhoades was telling us

about. And I think that to maintain that and improve on that, we need to both enhance the effectiveness of front-end research and development on the SBIR program by not only ensuring that that program is successful by giving companies the flexibility to have the funding there to execute on demonstrating those new ideas, but also by keeping important programs, like the ATP program, alive that can actually move those technologies from prototype to the types of capabilities that Mr. Rhoades has brought on line.

Mrs. BIGGERT. And then with that theory, since we do—people need jobs, we are going to have to raise all of the—through education, raise the base of skill level, too, and then have many more products that we can do.

Thank you very much.

Chairman EHLERS. The gentlelady's time has expired. Next, we recognize the gentleman from Washington, Mr. Baird.

Mr. BAIRD. [No response]

Chairman EHLERS. Okay. I am sorry. We had the order changed here. Pleased to recognize Mr. Miller.

Mr. MILLER. Thank you. Dr. Eagar, is that—Dr. Eagar. What is that? Dr. Eagar, your testimony is essentially that there is a natural kind of evolution of the economy and that there are industries like textiles that we should expect will probably cease to be American industries and will move, naturally, to other parts of the world. But at the same time, there will be other industries that will appear instead of industries like textiles.

Mr. EAGAR. Yes, but some of the industries can come back. Some of consumer electronics, which we lost in the '50's and '60's——

Mr. MILLER. Right.

Mr. EAGAR [continuing]. Has come back because of new technologies, for example. So you don't lose them forever, but when the—when an industry matures and it becomes—they have gone down the learning curve and it has become a commodity and other people develop the technology, you don't really want that industry, because it is commodity pricing. It is not highly profitable. You want the profitable, the high-value industries. And those are built on new technology.

Mr. MILLER. You know, at some level, I do agree with you, on an intellectual level, but I also represent a whole lot of textile workers, and I have been in a room and looked at them and heard what their concerns are. They went straight from high school. Maybe they graduated, maybe they didn't. It didn't much matter. They went straight to the mill, the same way their parents did before them. They are now middle-aged. Before they can be trained for new jobs, they have got to go back and get a GED. Your testimony reads a lot better than it reads. Those folks are living that transition. And I just—I understand what you are saying, and it may be correct. But it may be some value to you to go spend some time with the textile workers so you can kind of understand, at the pit of your stomach, what life is like for the people who are going through that transition.

Mr. EAGAR. Two of my uncles got textile engineering degrees from Georgia Tech, so I think I have some knowledge of what you are talking about. The transitions that occur are very painful, extremely. I am a—I was in the steel industry, and you can go talk

to—I have talked to steel workers. I know what it is like. The problem is, if they have got an education, they can go on to the next industry. It is when they are out of the job and—completely, and they have no other skills except going to McDonald's, that is when the Nation has done a disservice to them.

Mr. MILLER. There are only so many McDonald's that Rockingham County can sustain, but——

Mr. EAGAR. Right.

THE ROLE OF VOCATIONAL TRAINING PROGRAMS

Mr. MILLER [continuing]. One of the proposals of the Bush Administration is to eliminate the principle source of federal funding for vocational training at colleges—at community colleges and technical colleges, the Carl Perkins Grant. There is supposedly something else out on the horizon that will provide some funding, a block grant program that will probably end up being more in high schools and technical and community colleges. What is your take on how sensible it is for this nation to be reducing our support for technical and community colleges for vocational training?

Mr. EAGAR. We need to encourage everyone at every level to get—to improve their educational level. Whatever level of intelligence we gain as a Nation is going to serve us in the future, and that is for the country as a whole. We need—and frankly, the elite schools like mine, we are going to take care of ourselves anyway. My mother was a schoolteacher. My father used to tell her, "You can't help the best students. They are going to do it on their own. They may not—you may not be able to help the worst, but it is the ones in the middle that really need the help." And that is the community colleges. Okay.

We have got to do something. We have got to make it—incentivize people. Rather than sitting at home, watching TV, get out and learn something, read something. I once told a bunch of people at my church, if you watch more than five hours of TV at night—or a week, you ought to go out and get a second job, because you have got too much time on your hands. Okay. Well, you know, unfortunately, that is 90 percent of America.

Mr. DUNWELL. I also sit on an——

Mr. MILLER. Yes, sir.

Mr. DUNWELL [continuing]. Advisory council of a community college that recently built a new lab that has construction trades, automotive trades, and the manufacturing trades in these sections of this new lab. And it is a wonderful opportunity for students and displaced workers to go and learn new skills. And you know, the manufacturing lab has a big stamping press where we are, you know, training people not only the specific hard skills but also the soft skills, the working with teams, the looking at the, you know, continuous improvement process. And so it is, you know, the community colleges and the support for those programs. I mean, that is a—very valuable.

Mr. MILLER. Well, a quick executive summary, then. You would agree with me that it is dumber than dirt to be cutting back our support for vocational training?

Mr. DUNWELL. Right.

Mr. MILLER. And Dr. Eagar, you agree as well?

Mr. EAGAR. Yes. Yes, I agree.

DEVELOPING A NATIONAL MANUFACTURING POLICY

Mr. MILLER. All right. One more question, Mr. Dunwell. You said that we needed a national policy to be encouraging manufacturing, that that is—our economy, our standard of living depends upon having a manufacturing base for the economy. And Dr. Eagar, I think you said much the same thing. Is it your impression that we have anything resembling that now?

Mr. DUNWELL. Any type of national policy? Absolutely not.

Mr. MILLER. Right.

Mr. DUNWELL. I mean, I—you know, I think that is why we are all here. And it is wonderful to be here. I mean a small little manufacturer like Wolverine with 50 employees to be able to talk to, you know, the Federal Government about what it needs to do is wonderful to know that you are listening to us. And you know, as we spoke earlier, you know, the action that comes out of this testimony is what we are after. And I know that other countries and Asia have very specific national policies related to, you know, their manufacturing stature and where they plan to go. If we can come up with a technology vent and education vent, if we can come up with all sorts of different action items to improve the national strategy, let us do it.

Chairman EHLERS. The gentleman's time has expired. Next we recognize Mr.—the gentleman from Minnesota, the Great State of Minnesota, the home of the Hormel Company, Mr. Gutknecht.

Mr. GUTKNECHT. And the manufacturer of the world's finest lunchmeat. And we want to thank the Chairman once again for stopping this besmirching of that wonderful lunchmeat.

I want to thank the Chairman and the Staff for putting together an excellent panel. And I want to thank all of you for coming here today. And I hope that other Members, who could not be here for the testimony, will at least get copies and look at this, because I found myself in agreement with virtually everything you said.

INVESTING IN DEVELOPMENT AND DEPLOYMENT

And some of the other questions that I was going to ask have already been asked. But I really want to throw this out for discussion, because it seems to me, in some respects, we are talking around this problem. And it seems to me that the core of the problem is why are so many of these manufacturing jobs leaving. Now I understand that some of the lower end, low-technology—I mean, I share with my colleague who just spoke, the problem. We had a small pajama manufacturing plant in my District. You can call that low-tech. They closed and moved to Mexico. We lost 200 jobs. The world will go on. But for those 200 people, that was extremely important. You know. And not all of those people are going to be retrained in—engineers or computer scientists or are going to sell insurance. I mean, ultimately, as policy-makers, it seems to me we have to ask bigger questions.

In fact, let me just throw out something here, because I think it is something that this committee even forgets. We spend a bundle in this country on R&D. We represent less than 6 percent of the

world's population, and the United States of America, between the governments, state, federal, local, between universities, foundations, and private corporations, we will invest over half of what the world will spend on research and development this year. The taxpayers—the best estimate I can get between the various departments, NSF, NIH, DARPA, all of the other agencies that do research at the federal level, we will spend about $29 billion on research this year. Now even in Washington, that is a lot of money.

Now the problem, it seems to me, is many of these ideas, and the frustration I think we are beginning to face is within 6 months of some of these new technologies coming on line, the manufacturing is going somewhere else. And it strikes me that we have to ask an even more important question, and that is: why is this happening?

And I have some theories, and maybe you can respond to them, because for example, this year, the average manufacturer saw their health insurance costs go up 13.7 percent. Now I don't have an MBA. And I didn't go to MIT, but I know that that is unsustainable. I met with a representative of General Motors the other night. Do you know how much they are going to spend this year—GM alone is going to spend this year on drugs, on pharmaceutical prescription drugs? They are going to spend $1.3 billion. That is for their employees and for their retirees. Now I will flat guarantee you Hyundai is not going to even come close to that in either category. This year, American industry will spend somewhere between $180 and $280 billion on liability, in other words, hiring attorneys, buying liability insurance. I will flat guarantee you they don't have to worry about those things in the Pacific Rim. That is not happening in Communist China. And it strikes me that we, as policy makers, have to ask these questions. Why are these jobs leaving? Because at the end of the day, we can't all sell insurance to each other. And I wonder if you guys would like to respond to that. And frankly, even if you don't want to respond now, I wish on the plane on the way home, you would take a few minutes and write the Committee, because these are big questions. We are spending a lot of money on research. The problem is, as soon as it becomes marketable, they are manufacturing it somewhere else and nobody is talking about some of those big problems that manufacturers face that they don't have to face if they produce somewhere else. Maybe you want to respond now or maybe you want to respond in the plane on the way home.

Thank you.

Mr. RHOADES. If pajamas are made the same way, and there is a high labor content in manufacturing the pajamas, they will be made in a market where the value of a unit of labor time is worth less than it is here. So the only way to keep the production of pajamas in the U.S. is to change the methods so that the labor content is lower and the product has some functionality, some customization, some special feature that overcomes the commodity product. But if we don't change the way we make things, then they will migrate to where labor costs are lower.

Mr. GUTKNECHT. Mr. Rhoades, I don't disagree with that, and I understand that. But why did IBM, in effect, spin-off its very high technology, disk drive business, and ultimately 500 jobs in the last year went to Communist China? Why did that happen?

Mr. EAGAR. Having worked in disk drive industry, it may be high technology to design them. To actually manufacture them is very labor-intensive. And so labor-intensive, we have a disadvantage. I learned that as a young faculty member. I could not compete with the other universities on a research basis at the high cost of my university. I had to compete on knowledge, not hands, how many hands I could put at the problem.

THE NEED FOR MORE APPLIED RESEARCH

But let me say something about the research investment. You are absolutely right; we invest plenty in research in this country. The problem is how we are investing it. We are not asking for a return on the investment. There are many scientists who have come, I am sure, to this room and told you knowledge for knowledge's sake is wonderful. They will tell you that is how we found the transistor. That is a myth. The people working on the transistor were charged with finding a replacement for the mechanical switch. They wanted an electronic switch that would not wear out as quickly. They weren't just looking for knowledge for knowledge's sake. They stumbled across an extremely valuable product, just like the laser and things like that.

We need to get a return on our investment on our basic research and then have an equal sized investment on the development of that into a commercially useful product. I could not get tenure at any major university in this country if I worked on development projects. It is not scientifically acceptable at the universities. Well, who is going to do it? We lost the labs. We don't do it in the companies anymore. What companies are spending money in the 5- to 20-year horizon? Where are the research labs in the companies? There are only a couple of them left at the semi-monopolistic, the Microsofts and Intels. But even that, you are starting to see some of them cut back a little bit. You can't do it.

We have got to justify where we spend our money. There are some huge ticket science items out there. And I am not going to start knocking a particular thing, that boy, if I had to vote on it as a taxpayer and as a knowledgeable scientist, you wouldn't get my vote to—for some of the things that we fund, because I can't see a return and in my tenth grandchildren's lifetime.

Mr. REININGA. A question to ask would be how much of that 29 billion that was spent on R&D was on manufacturing R&D? Very little. That is why we are here. That is what we are asking, to raise that level in either the DOD or in industry itself or NIST or wherever.

Chairman EHLERS. Okay. The gentleman's time has expired. And next we turn to Mr. Baird.

Mr. BAIRD. I thank the Chairman. I thank my Ranking Member.

EMPLOYMENT IN LOCAL ECONOMIES

I am particularly pleased at this hearing, because so often we hear about the loss of manufacturing jobs and I think the witnesses have done an outstanding job of describing ways in which we can help improve our manufacturing competitiveness. And I think the points that were just made were very valid. I want to use the case

in—of nLight Photonics to illustrate that a little bit and ask Mr. Farmer, can you describe a little bit about how many jobs you have brought to the area with the development of your company?

Mr. FARMER. We raised $55 million and created about 70 jobs. This is—we are addressing a market. The entire high-power laser market today is something like $1.3 billion. Semiconductor lasers with, you know, smaller sizes, higher efficiencies, lower cost can, I think, displace a large portion of that and are positioned to grow by a factor of four or five and displace most of that market within the next five years or so. So I think that if—you know, with the investment in the manufacturing technology that we will get those performance improvements as well as the manufacturing improvements that will lower the cost will enable that to happen.

Mr. BAIRD. One of the aspects that particularly intrigues me about this and about some of the programs we have described, is that they often help cutting-edge companies, who might not have the capital in reserves. A large corporation may have capital in ready reserve, and it can have its own research team, etcetera. But if you have got a new idea, the kind of idea I think was referred to maybe as a disruptive technology, something that is going to jump us forward, you don't have that capital reserve. And yet you actually have the thing that is going to take our economy forward or our defense industry or homeland security forward. Has that been the kind of experience you have had? And after Mr. Farmer speaks, if others can comment on that, I would appreciate it.

Mr. FARMER. Absolutely. I think that is where most of the technology innovation is going on nowadays is in the small businesses and small companies. And those companies today don't have the capital to move these technologies to the point where they need to be. And that is where programs like the ATP and ManTech are, I believe, of critical importance.

Mr. BAIRD. Would anyone else like to comment on that?

Mr. RHOADES. In this process, I mentioned of digitally assembling metal particles with a device that is a lot like an inkjet printer printing little droplets of glue that was enabled by ATP is now embraced in defense manufacturing to make low-volume spare parts for much needed aging weapon systems operating at twice their design life. They can't even find the tooling for the spare parts anymore. The ability to take a computer-designed file or a replica—or a legacy part and then make a spare part that is fully functional is saving the Department of Defense a great deal of money that will then migrate into other markets where the value of a spare part isn't quite as high as it is for defense systems. So all of that is integrated. And there is a normal commercial path once the validation is done. But the validation step, that "valley of death", that risk area that is not rational for the pioneer to take on his own, because most of the benefit goes to the users and their customers and ultimately the consumers where the Federal Government gets to tax the entire chain, if it stays in the U.S.

INDUSTRIES IN TRANSITION

Mr. BAIRD. Interestingly enough, another company in my own District, Windsor Corp., makes display panels. I was thinking of Mr. Reininga's comments that—about your need for display panels.

They are in the same kind of situation. It is a very innovative technology. It is exciting. It is fun to visit their plant, and yet they are also struggling with that capital access. And they have a technology that could move us forward. Maybe we could chat later about that link up.

Part of the reason I raised this, you know, we are in a transition, a transition in two ways. Our—Vancouver, Washington was the home of the Liberty ships. And I like to say that we are moving from Liberty ships to Liberty chips. But at the same time, we also are making real strides in the manufacturing. And I am thinking of Mr. Dunwell's type of company. Maybe a more traditional company, but we need to help you be more competitive in your manufacturing. Are there ways, Mr. Dunwell, that we can help a company that may have a more traditional kind of industry be more efficient, more cost-effective, etcetera, through government programs?

Mr. DUNWELL. As I have—certainly, as I have stated earlier. I mean, the MEP is very great and very helpful in, you know, organizing local companies and ideas and best practices. So that certainly helps the small manufacturer and the supply chain continue to be successful. But I—you know, the bigger picture is still that, you know, are we going to wake up some day and all of our customers have left? I mean, and that is my serious concern is that it is helping companies around me and this table that if we can help them be successful, this supply chain will survive as well. And you know, but my worry is how fast this is happening.

Mr. BAIRD. The loss of our manufacturing base is——

Mr. DUNWELL. The loss of the jobs is happening——

Mr. BAIRD [continuing]. Terrifying.

Mr. DUNWELL [continuing]. So quickly.

Mr. BAIRD. Yeah.

Mr. DUNWELL. And if there is nothing happening to slow that down or to prevent this from continuing at the pace it is, there are going to be a lot of companies like mine that are just going to wake up someday and say, "Gee, I was the low-cost producer, I thought, and I thought I was doing a great job. And gee, where did all of my customers go?"

Mr. BAIRD. I thank the Chairman.

Chairman EHLERS. The gentleman's time has expired. I am pleased to recognize the gentleman from Texas, Dr. Burgess.

IS ATP HELPING MANUFACTURING?

Dr. BURGESS. Thank you, Mr. Chairman. And thank you for holding this hearing. And you may have already covered this when you answered the Ranking Member's question, Mr. Udall's question, but I guess the—and at the risk of just sounding too pedantic and too basic after all of the educated talk that we have heard here today, are we really helping here at our level, or are we, in fact, simply delaying the inevitable? Is it reasonable to continue to do what we do if we are going to continue to do it with such an anemic response, such as the ATP program? Would we all be better served if we got out and stopped being the enabler and let the private sector work this out on its own? Probably, I would ask Mr. Rhoades, because he had the—that is a very attractive idea that you have

got there with the digital building of legacy parts. As a former owner of a very old airplane, I can certainly identify with that. But are we helping or are we hurting ultimately?

Mr. RHOADES. You are certainly not hurting. The difficulty and the gap that the ATP program fills, and very intelligently fills in both where it chooses to invest on behalf of the taxpayer and in the recognition that it is, indeed, investing on behalf of the taxpayer in selecting its projects, is a wonderful model. And the ATP projects that I am aware of, have—although they are chosen to be quite risky, have a remarkable rate of return on them and not all of them are successful, but enough of them are successful that it is a very wise investment on behalf of the taxpayer.

The issue for the private sector, if the government got out, then you are asking the private sector to take that risk entirely on its own. And the ability to fence the benefits of the value created is quite limited. So it is not rational for a private sector company to make that investment on their own, because most of the benefit, and by—when I say "most," I mean 99 percent of the benefit falls to the customers who buy the machines that we will sell them to do this and to the customers of theirs who will be able to get low-volume spare parts without waiting, and ultimately to the consumers who are counting on having these products that might have new functionality because of the abilities of the process. All of that, I can not capture. I am too small. I don't have the negotiating position. And ideas and knowledge flow quickly, especially within a nation. So consequently, the ATP investment on behalf of the taxpayer has a return, because the Federal Government is able to tax all beneficiaries within the chain who fall within its taxing authority, which is within the United States. And by developing processes that are uniquely responsive to U.S. imperative advantages in manufacturing as opposed to world and low-labor rate markets, then we are able to have a strategy that, on behalf of America Inc., makes a whole lot of sense with very, very high rates of return, a small amount of which I will be able to capture as an innovator. But most of that is going to flow to my customers and their customers and so on.

Mr. REININGA. We do see some international companies moving into the U.S., back into the U.S.—or into the U.S. We see BMW. We see Toyota. And what we are kind of predicting is that that is the mass customization is coming back to the U.S. So we will be able to take advantage of that. Do we need support from the government to help U.S. industry compete? Absolutely. That is what we need to continue to drive and improve on.

Mr. FARMER. I would submit, very quickly, that your role is governance and that we are, as we heard, investing $29 billion a year in R&D. You need to demand that that results in better U.S. technology and manufacturing and provide the governance that makes that investment a wise one.

Mr. EAGAR. I would submit it is mostly about risk. Research and development is moving into the unknown, and there are certain levels of risk. Industry is limited in the amount of risk it can assume. The government can help take some of that risk, as they do in the ATP where they pay 40 percent and they require the companies to pay 60 percent. You just gave us 40-percent risk reduction.

And hopefully the people who are administering that will make wise choices. I think they have.

So it is all about risk. To assume that industry will take on any risk possible is sort of absurd. They will not take any risk possible. They are only going to take the best risks, and if you help them get over certain hurdles, there is one—there are some risks they can say, "Gee, there is a—it is a beautiful field over there. It is a lot greener pasture over there, but it is just a little bit more than my stockholders can afford." Well, the government can help them with that, because the types of things that the ATP is doing are not just helping that one company. You want to say it is corporate welfare? As long as it corporate welfare for all of the companies that are in—competing in that business, so what. If it is corporate welfare for one company, I agree, that is a problem. But when it is corporate welfare for the Nation's manufacturing base, I am not opposed to that.

Chairman EHLERS. The gentleman's time has expired. Next, we recognize the gentleman from Michigan, Mr. Smith.

DIRECTING APPLIED RESEARCH IN FEDERAL FUNDING

Mr. SMITH OF MICHIGAN. Mr. Chairman, thank you. And I have missed a lot of your comments. I have walked in this last time when you and Mr. Eagar was—were talking about knowledge for knowledge's sake is fine and dandy philosophically, and I just wanted to cheer. I have been on the Science Committee now for 11 years pushing that we have got to have more flexibility in terms of moving into the arena of applied research as well as basic research. I chair the Subcommittee on Research that oversees the NSF. We have made progress. Now we are a little more flexible.

I—by the time I get through my speech, Mr. Chairman, we might have finished my time limit. Perfunctory, you usually say, "Thank you for holding this important hearing." This is probably the damnedest most important thing that the United States is going to be facing over the next several years. In 1949, 41 percent of our non-farm employment was manufacturing. Now it is down to a little over 11 percent. We are losing our manufacturing base. And what concerns me almost as significantly as we sort of change to a service and high-tech economy, in the last two years, we have lost 560,000 workers in the high-tech arena.

I met with the Vice President of Motorola. They are moving their engineering labs to India. I think, as I have a hearing in my Subcommittee on Research on tech transfers out of our university, I would like to have all of you be on those panels, too. I am not sure what we do. As I meet with Australia and some of these other countries and asked for their—how they spend their government money, they say that they spend half of it on copying what we are doing in basic research in the United States and the other half trying to get it applied. So we now see other countries that are taking our knowledge for knowledge's sake and trying to get it applied faster than we do.

And with that, your suggestions. Just—I have got two other Committee meetings going. One discussion was on taxes. We have modified our taxes a little bit, trying to make our taxes a little more comparable with some of our competitors. Maybe that is part

of it, but of—the other part is how do we be more selfish in terms of our basic research and developing—moving that into the application where it is useful. And just go down the—maybe go down the row, and you can give me a short suggestion of where we go from here.

THE NEED FOR INCENTIVES

Mr. EAGAR. We certainly need incentives. I am not smart enough to tell you whether that is a tax incentive, an investment credit, an education break for the—or for the companies that fund education, because the—investment education is not just an investment and that—working for that company. It is a national investment. And the government ought to find some way to incentivize the company to do that. You ought to—we ought to find ways, like the ATP program or SBIR for companies to take higher risks, because with higher risks, there is higher payoff. And we have got to do that. Companies are risk averse. And I am sorry, you know. I will try to irritate everyone here. You know, the universities aren't doing their job and the companies aren't doing their job. We are risk averse.

The government needs to encourage and incentivize taking higher risks in research and development, not risks that are foolish, but risks that have a good potential payoff.

Mr. SMITH OF MICHIGAN. Mr. Rhoades.

EXPANSION OF EXISTING FEDERAL PROGRAMS

Mr. RHOADES. I think, first of all, the $29 billion that has been bandied about, the vast majority of that has been spent on life sciences and a very, very small amount has been spent on manufacturing, even as critical as manufacturing is to the economy. I think you have structures in place that can be expanded to make significant differences in the economy. One is certainly the defense manufacturing effort that helps our nation's defense industrial base strengthen. The second is the MEP program, which helps the small, medium-sized manufacturers who carry the bulk of manufacturing tasks in the United States. That has shifted over the past 20 or 30 years. And small manufacturers are really the people who are doing the—making things in the U.S. And the MEP program helps advise them with an infrastructure to help them be modern.

The ATP program, in my view, should be dramatically expanded to expand the menu of manufacturing methods that are available to make pajamas, make metal parts, make semiconductor display—make semiconductors, make panel displays so that we have manufacturing methods that are appropriate to U.S. economics. And third, and finally, I think encouraging the assembly of many—of consortia of product designers and new process developers so that the two of them can work together to enable products to be made in special ways.

Mr. REININGA. The ManTech program should definitely be expanded beyond where it is at today for the DOD. That would help a lot. I was pleased to hear about a central focus point for manufacturing at the Cabinet level or at least working for the Department

of Commerce. That single focal point would be outstanding and really help drive and create a national policy.

Mr. DUNWELL. I will reiterate. I mean, the MEP, the NCFAM, the National Coalition for Advanced Manufacturing, ATP, I mean all of these programs seem to be helping companies. And all of us are saying, I think, the same thing: "Let us do more of it, and let us be strategic about it. Let us think about how we can put this together better and continue to support that very vital manufacturing base for our country."

Mr. SMITH OF MICHIGAN. Mr. Farmer.

Mr. FARMER. I think that the key difference between tax cuts and the programs that we have been discussing today are that the tax cuts can help people with larger companies, with a more established revenue base. Smaller companies that are facing the "valley of death" don't benefit greatly from tax cuts. And I think the other big difference is that with the ATP program and other programs such as that, the government can execute a focused strategy to become the real technology and manufacturing leaders around the world. And those programs, I think, are very important.

Mr. SMITH OF MICHIGAN. Thank you very much. Mr. Chairman, thank you. Mr. Eagar, I had a job with Bethlehem Steel, and then I went home and a farm came up for sale, and I got it at a good price, so I became a farmer.

Thank you all very much. Mr. Chairman, thank you.

Chairman EHLERS. The gentleman's time has expired, and I must say, you made a wise choice, given what happened to Bethlehem Steel.

I had hoped to have a second round of questions. There are a number of things that I would like to ask, but as you heard bells, we are being called to the Floor for votes. And I don't want to detain you here for another half-hour or 45 minutes just for a few more questions. So my suggestion is that what remaining questions anyone on the panel has, we will send to you in writing. If you would be kind enough to respond, then we would—are able to conclude the hearing at this point.

I certainly want to thank you. It has been an excellent panel: very, very helpful to me. I have given several speeches in the recent past simply stating that manufacturing in the United States is in great trouble. That has given me a lot of press in the technical press, but I don't have answers yet. But you have helped provide some answers.

One thing I might mention, we just talked briefly about taxes. When I wrote a book several years ago trying to develop a new national science policy, I emphasized in there the essential nature of having a good R&D tax deduction, or better yet, a tax credit. And that—this, I think, would be a great help, allowing the companies to decide on their own what to spend the money on, make it a tax credit, but we have to make it permanent. And we have had one that goes year by year, which to me, is absolutely useless, because no one is going to invest money into research on a year by year basis, because it may take 5 or 10 years. So that is one step we could do, but there is much more we can do. And I appreciate the suggestions made. We will incorporate them into our thinking, and

see what we can come up with in terms of innovative ideas and approaches to solve some of these problems.

Thank you again. You have been most helpful to us. Your testimony has been excellent. And we appreciate you taking the time to be here.

With that, I will recess the—I will adjourn the hearing.

[Whereupon, at 11:55 a.m., the Subcommittee was adjourned.]

Appendix 1:

Biographies, Financial Disclosures, and Answers to Post-Hearing Questions

BIOGRAPHY FOR THOMAS W. EAGAR

Thomas W. Eagar is the Thomas Lord Professor of Materials Engineering and Engineering Systems at the Massachusetts Institute of Technology. Prior professional assignments at MIT included head of the Department of Materials Science and Engineering, director of the Materials Processing Center and co-director of the Leaders for Manufacturing Program. Professor Eagar has served on various technical committees for U.S. governmental departments and agencies, and has held numerous positions in many professional associations. Professor Eagar's numerous awards include Nelson W. Taylor Lecturer, Pennsylvania State University (1995); William Irrgang Award, American Welding Society (1993); Henry Marion Howe Medal, ASM International (1992); and Comfort A. Adams Lecturer, American Welding Society. Thomas Eagar holds Fellowships in the American Welding Society and the American Society for Metals International, and the American Academy of Arts and Sciences, and has served on many NRC panels and committees. Professor Eagar is the author or co-author of over 193 publications in national and international journals and the co-inventor of 13 U.S. Patents including 3 additional U.S. Patent Pending.

Mr. Thomas Eagar
Massachusetts Institute of Technology, Room 4-136
77 Massachusetts Ave
Cambridge, MA 02139

Honorable Vernon Ehlers
Chairman, Subcommittee on Environment, Technology and Standards
Committee on Science
2320 Rayburn House Office Building
Washington, D.C. 20515

RE: Financial Disclosure of Persons Providing Testimony

Dear Congressman Ehlers,

Your staff has requested disclosure of my sources and amounts of Federal Government funding over the past two years in preparation for my testimony on June 5 at 10:00 a.m. before the Subcommittee on the Environment, Technology and Standards.

My Federal agency funding has consisted of:

1. U.S. Navy Office of Naval Research - two contracts totaling $250,000 per year on
health effects of welding fume and manufacture of linear metal foam composites.

2. U.S. Department of Energy

a. Basic Energy Sciences - modeling and scaling of Materials Processing
$160,000 per year

b. National Energy Technology Laboratory - $300,000 per year on metal ceramic bonding for energy conversion.

Please let me know if you require further details.

Sincerely yours,

Thomas W. Eagar

Thomas W. Eagar

ANSWERS TO POST-HEARING QUESTIONS

Responses by Thomas W. Eagar, Professor, Massachusetts Institute of Technology

Questions submitted by Chairman Vernon J. Ehlers

Q1. How would you define the term "Manufacturing R&D?" How does R&D for manufacturing differ from basic or applied R&D?

A1. I would define basic research as research in search of knowledge. Applied research or applied development has a purpose of producing products (other than mere knowledge). Manufacturing R&D has a purpose of producing products or aiding in production of products which would be marketed and sold. Manufacturing R&D is market driven.

I would note that I have never heard anyone discuss "basic development;" basic (or knowledge driven) is a term applied to research, rather than to development. I believe the United States is well invested in basic research but is significantly under invested in development of the fruits of our basic research.

Q2. Based on witness testimony and the discussion during the hearing, there was a sense that it would be beneficial for the United States to have a manufacturing R&D strategy. How would you recommend such a strategy be crafted? Who should be included in the development of such a strategy? What would the major elements of such a strategy be?

A2. The problem with discussion of "manufacturing strategy" is that everyone knows what they mean personally by manufacturing strategy, but the term manufacturing strategy does not have a universal meaning.

If manufacturing strategy means that the government should become involved in picking winning and losing industries within the United States, as some countries do within their own borders, then I do not favor a government mandated strategy. If manufacturing strategy means that the government should implement policies, which permit manufacturing industries to grow and develop, then there is a vital role. For example, in the entrance hall of NIST in Gaithersburg, MD, there is a nearly century old quote that establishments of standards is the greatest benefit that government can provide for industry. In our increasingly complex world, there are many factors which influence the competitiveness of U.S. companies abroad. These should be identified and studied, on a continuous basis, by manufacturing leaders for government, industry and academia. A forum for such studies already exists as the National Research Council of the National Academies of Science and of Engineering. The problem is that the finding structure of the NRC infrequently provides a forum for the high level strategic questions which should assist Congress in making policy. The National Academies attract the correct mix and level of people to address the questions of National Manufacturing strategy; but, the agencies funding the studies are infrequently asking the Academies to address the higher level questions of a national manufacturing strategy. If even modest continuing funding of such questions were provided to the NRC, Congress would see senior level people competing to serve gratis on such panels, in hopes of making their voices known.

Congress should charge the NAS–NAE–NRC–IOM with providing an annual report of national needs in manufacturing.

In my opinion, it would be unwise to create another organization or Advisory Panel to define a national manufacturing strategy. The organizational structure to vet a wide range of opinions and to prevent a few individuals from dominating the agenda, already exists within the National Academies. Congress should make more complete use of this resource.

Question submitted by Representative Nick Smith

Q1. What do you think the Federal Government should be doing to support applied manufacturing research?

A1. I believe that the ATP of NIST within the Department of Commerce is well conceived and has been well managed, to support the innovation process which will create new industries and new jobs for the United States. The view that the ATP is merely welfare for large corporations who are getting the government to fund the development that they would be doing themselves without government assistance is too simplistic. This view pre-supposes that the managers of the ATP are not capable of assessing risk and pre-competitive technologies. This view assumes that anything, which comes from basic research should move seamlessly, without government assistance, to the marketplace. Nearly everyone associated with the transition from

basic research to a marketable product has been saying for decades that this is not true. The "valley of death" is one of our greatest challenges. The ATP was designed to bridge this valley. Without a significant investment in the ATP or ATP-like programs, we are squandering our investment in basic research. The Department of Defense spends more on development than it does on basic science, because they recognize the need to assist the development process if the newest technology is to be brought to market quickly. Without the ATP, the United States has nothing to assist in bridging the valley of death for the commercial sector of our jobs creating industries.

BIOGRAPHY FOR LAWRENCE J. RHOADES

Lawrence Rhoades studied Economics and Mechanical Engineering at Brown University and received his M.B.A. from Northwestern University. He is President and Chief Executive Officer of Extrude Hone Corporation—a leading developer and supplier of manufacturing technology and equipment, serving the majority of the world's largest manufacturers. Extrude Hone has 22 locations in major manufacturing centers throughout the world. He holds patents on more than two dozen inventions related to nontraditional manufacturing processes for machining, finishing, forming and measurement.

He has chaired the Advisory Committee of the U.S. Export Import Bank, and has served on numerous advisory groups for the U.S. Department of Defense and the Department of Commerce, addressing both technologies and business practices related to manufacturing. Mr. Rhoades has served on the Boards of Concurrent Technologies Corporation, the National Center for Manufacturing Sciences, the World Trade Center Pittsburgh, the Pittsburgh Regional Alliance, the National Institute for Standards and Technology's (NIST's) Manufacturing Extension Partnership (MEP) Program, and the Western Pennsylvania's MEP Center (Catalyst Connection) which he chaired through 2000. He currently serves on the Boards of the Pittsburgh Symphony Orchestra, the Society of Manufacturing Engineers' Education Foundation and the Association for Manufacturing Technology (AMT) which he currently chairs.

In June of 2001, he was elected a Fellow of the Society of Manufacturing Engineers. He is also a member of the National Academies' Government-University-Industry Research Roundtable and the Pennsylvania Bar Association's Judicial Evaluation Commission.

EXTRUDEHONE

Innovation In The Pursuit Of Excellence®

Fax 202 225 4438

June 4, 2003

Attention: Elyse Stratton

Attention: Chairman of Subcommittee on Environment, Technology, and Standards

Lawrence J. Rhoades, the CEO and major stock holder of Extrude Hone Corp., will be appearing June 5 before the Subcommittee on Environment, Technology, and Standards for the hearing: Manufacturing R&D: How Can the Federal Government Help?

Our corporation has received $9,443,251 in government funding during our current and last two fiscal years. The funding is detailed on the attached spread sheet.

Please call me if I can be of any further assistance. My phone number is 248 547 3133.

Sincerely

Doris Pedersen

Doris Pedersen
CFO
Extrude Hone Corp.

1 Industry Boulevard • P. O. Box 1000 • Irwin, PA 15642
Telephone (724) 863-5900 or Toll Free 1-800-367-1109 • FAX (724) 863-8759

EXTRUDE HONE CORPORATION-IRWIN
ANALYSIS OF GOVERNMENT RELATED FUNDS RECEIVED
THREE FISCAL YEARS ENDING JUNE 30, 2003

DEPARTMENT	SOURCE	PROJECT	Payments Received 7/1/00 - 6/30/01 FY 2001	7/1/01-6/30/02 FY 2002	7/1/02-6/30/03 FY2003	TOTAL
Department of Defense	Office of Navel Research	E- Manufacturing using 3D Printing	$ 1,877,329.00	$ 1,662,033.00	$ 1,337,237.50	$ 4,896,599.50
Department of Defense	MANTECH/ARL	Femtolaser Research	$ -	$ -	$ 2,501,696.25	$ 2,501,696.25
Department of Defense	Air Force SBIR	Micron Drilling Project	$ -	$ -	$ 87,479.00	$ 87,479.00
National Science Foundation	National Science Foundation	Distriubted Design Project	123633.93	0	0	$ 123,633.93
Department of Defense	MANTECH/ONR	Coating Removal Phase II	2572.32	46068.64	173.09	$ 48,814.05
Department of Defense	MANTECH/ONR	Short Pulse Laser Workstation	0	63946.39	74431.61	$ 138,378.00
Department of Commerce	MANTECH/DLA	PROFAST for Forging Tooling	11033.82	68153.1	112482.71	$ 191,669.63
Department of Commerce	NIST	3DP for Lost Foam Tooling	677266	632715	145000	$ 1,454,981.00
			$ 2,691,835.07	$ 2,492,916.13	$ 4,258,500.16	$ 9,443,251.36

ANSWERS TO POST-HEARING QUESTIONS

Responses by Lawrence J. Rhoades, President, Extrude Hone Corporation

Q1. What are the most serious long-run problems facing U.S. manufacturing? To what extent do these represent significant structural problems beyond the recession?

A1. Manufacturing R&D is directed to R&D on the *processes* used to manufacture products

- to make manufacturing tasks more efficient
- more importantly, to enhance the value of products (e.g., by enabling previously unmanufacturable or excessively expensive designs).

This is connected to, but extends well beyond, most applied R&D, which is directed to *product design*—but *constrained* by "design for manufacturability" concerns.

Q2. Is there anything in the existing inventory of Federal or State research and development programs that could play a more significant role in establishing a stronger manufacturing-specific R&D and technical assistance base?

A2. The manufacturing R&D strategy needs to *link* the product design opportunities with the manufacturing process design opportunities—as well as the "new science" that can be harnessed to become new manufacturing processes.

This suggests—perhaps demands—that rather disparate cultures collaborate including:

A. Influential *product* designers/manufacturers (usually Fortune 100 industrial firms).

B. Manufacturing *process* technology innovators/implementors—usually smaller companies who are manufacturing technology providers supplying machines, tools, manufacturing systems, etc., to the Nation's industrial base. They are the focal points and repositories of manufacturing process "know-how."

C. "New Science" researchers (mostly universities—also national labs and others).

Public investment should center on the manufacturing *process* innovators. This is the leverage point. There are only about 350 key companies in the U.S. (maybe twice this number). Altogether no more than 2000 organizations in the U.S. currently comprise the existing manufacturing technology infrastructure. Impacting 10–20 percent of these would dramatically improve the Nation's manufacturing technology infrastructure and consequently U.S. industrial productivity and competitiveness.

Programs should be directed to the development and rapid, widespread implementation of advanced manufacturing *processes* (i.e., the methods used to make products), supported by sound science, which are relevant—indeed transformative and enabling—to the much more numerous U.S. *product* manufacturers who *use* these processes to make their products.

Funding should encourage integrated teams centered on, and led by, manufacturing process technology innovators/implementers that *link* research centers (providing breakthrough science, or simply sound scientific understanding, related to manufacturing processes) and product manufacturers (who can and will design products to exploit the new value offered by the developed processes).

"Process innovations" is meant to include new materials and applications of materials to manufactured products.

Many elements of the NIST ATP "focused program" model should be included, with an emphasis on manufacturing process development, seeking widespread economic impact and strategies that can build a durable U.S. competitive advantage.

Q3. In addition to current efforts, please provide specific suggestions of what the Federal or State governments could do to assist manufacturing with research, development, and technology in meeting their long-term needs.

A3. Manufacturing activity represents 17 percent of the GDP. The inability of manufacturing process innovators to harness the benefits of their developments and the *product* (vs. process) focus of large manufacturing enterprises leaves an under-investment in manufacturing *process* development. From a "USA Inc." perspective, this investment would provide extraordinary yields to the taxpayer. An investment by the U.S. taxpayer of 0.1 percent of manufacturing's share of the U.S. economy would be large enough to make a real difference and still small enough to focus on

very high payoff opportunities that would generate manufacturing related profits, jobs and consequent marginal tax revenues that are greater than any other investment that the U.S. taxpayer could make.

$10T x 17% = $1.7T
0.1%
$1.7B/year

with about half this amount going to the manufacturing process technology innovator/implementers.

Similar investment in education relevant to manufacturing and to manufacturing technology implementation (ala MEP, but improved) would have similar yields.

I firmly believe that over a decade these investments would reinvigorate U.S. manufacturing and return ten times this investment in annual tax revenue that will otherwise be lost.

BIOGRAPHY FOR HERMAN M. REININGA

Herman M. (Herm) Reininga is Senior Vice President of Operations for Rockwell Collins. Additionally, he is a corporate officer of Rockwell Collins. Reininga is responsible for overall management of Rockwell Collins' global production and material operations, including manufacturing, material, quality, and facilities and manufacturing activities. He was named to the position in June 2001.

Previously, Reininga served as Vice President of Operations for the company, a position he was appointed to in 1985. Reininga joined the company in 1965 and has held positions of increasing responsibility, including director of Operations CTPD and Director of Production Operations.

A native of Waverly, Iowa, Reininga earned a Bachelor of Science degree in Industrial Engineering from the University of Iowa. He earned a Master of Industrial Engineering degree from Iowa State University.

Reininga is a member of the following organizations: The National Academies Board of Manufacturing and Engineering Design, AFEI (Association for Enterprise Integration), Chairman of the U.S. Army's Future Combat Systems Critical Manufacturing Technologies Independent Assessment Panel; the U.S. Air Force ManTech 2015 ExCom Committee; Chairman of the National Center for Advanced Technology (NCAT) and Chairman of the Subcommittee on Multi-use Manufacturing; Chairman of the Integrated Manufacturing Technology Initiative (IMTI); member of the U.S. Air Force ManTech Strategic Planning Executive Committee; project reviewer for the U.S. Department of Defense (DOD) Technologies Area Review and Assessment for the National Science Foundation and National Center of Manufacturing Sciences; appointed member of the National Research Council; member of the U.S. Navy's Electronic Manufacturing Productivity Facility Advisory Board, industry representative on the Electronics Processing and Manufacturing (EP&M) subpanel; member of the Aerospace Industries Association (AIA) Technical Operations Executive Committee and Electronics Manufacturing advisory panels.

From 1990 until 1992, Reininga served on the Defense Science Board (DSB), a 30-member civilian advisory panel composed of leaders from industry and academia, appointed by the White House, to provide support and guidance to the Secretary of Defense. He testified in front of the Senate Armed Services Committee on Defense Technology, Acquisition and Industrial Base. Reininga chaired DSB's Production Technology Subgroup for Weapons Development Production Technology Summer Studies program which developed a manufacturing technology strategy for the U.S. DOD. He is called upon regularly to provide perspective for future manufacturing strategies.

In June 2001, Reininga was inducted into the University of lowa College of Engineering Distinguished Engineering Alumni Academy. In 1999, he received the prestigious Meritorious Public Service Citation by the Chief of Naval Research, Department of the U.S. Navy. In 1998 he was awarded the Defense Manufacturing Excellence award endorsed by nine national trade associations and professional societies. He received the Professional Achievement Citation in Engineering (PACE) award from Iowa State in 1993.

Reininga is a member of the Armed Forces Communications and Electronics Association (AFCEA). He also has developed and taught junior college courses on Production Control Master Scheduling.

Reininga is a member of the Board of Directors for the Cedar Rapids Concert Chorale and is Chairman of the Board of Trustees for the Young Parents Network. Additionally, he is a member of the University of Iowa Engineering Development Council, University of Iowa Interaction Advisory Board for Industrial Engineering and the Iowa State University College of Industrial Engineering. Reininga is a member of the Stewardship Committee for Christ Episcopal Church.

400 Collins Road NE
Cedar Rapids, Iowa 52498
Tel. 319.295.1000

Rockwell Collins

June 4, 2003

The Honorable Vernon Ehlers, Chair
Environmental, Technology and Standards Subcommittee
House Science Committee
U.S. House of Representatives
Washington, D.C. 20515

Dear Congressman Ehlers:

The purpose of this letter is in compliance with procedures governing witnesses testifying before the Committee on Science for the 108th Congress. On Thursday, June 5, 2003, Mr. Herman Reininga, senior vice president, Rockwell Collins will be presenting testimony to the Environmental, Technology and Standards Subcommittee on "Manufacturing Research and Development, How Can the Federal Government Help." As such, I am advising the subcommittee of applicable financial disclosures relative to Mr. Reininga's testimony.

As discussed with Ms. Olwen Huxley of the Committee staff, the only applicable disclosure is a Department of Defense contract to Rockwell Collins for ManTech funding for the Navy's Link 16 program in the amount of $6 million over 3 years. This program funding began in FY 2003.

I have also enclosed a copy of Mr. Reininga's biography as required by the rules governing testimony. Please contact me if you have any further questions.

Sincerely,

Tom Hobson

Thomas R. Hobson, Senior Manager
Government and Public Affairs

cc: Herm Reininga

Attachment

ANSWERS TO POST-HEARING QUESTIONS

Responses by Herman M. Reininga, Senior Vice President, Special Projects, Rockwell Collins

Questions submitted by Chairman Vernon J. Ehlers

Q1. How would you define the term "Manufacturing R&D"?

A1. Manufacturing technology contains hardware, software, and human components. Not only must the future be imagined, it must be manufactured. Manufacturing takes the engineering designs loaded with the latest technologies, and by using tools, material, software and people, create the realization of the design in a product. New technology requires new processes, materials, and techniques, manufacturing R&D develops those tools. Manufacturing R&D is a set of activities that support the design of the product and of the development of processes, including tools and techniques.

Q1a. How does R&D for manufacturing differ from basic applied R&D?

A1a. Development programs (with few exceptions) do not plan for, nor do they provide timely development of affordable, producible technology or their associated manufacturing technologies. Rather in general they plan and fund for transition of technology performance. This can hinder technology transition resulting in acquisitions and program schedule delays. In addition, it can drive cost increases as basic manufacturing technology issues have to be solved later in the program, either during systems development and demonstration phase or even during production. The opportunity to employ a particular technology could, in fact have been missed entirely if the associated manufacturing processes were not significantly mature. The U.S. government is spending 29 billion plus on "big science," in hopes to boost national competitiveness. Unfortunately only a small amount is being spent on manufacturing R&D. Basic R&D investigates the scientific foundations with a major objective of pushing forward the frontiers of intellectual knowledge.

Applied R&D is a much broader umbrella and may include any activity focused on taking knowledge or science to a functional utility of a particular new product.

Manufacturing R&D includes both basic and applied R&D, with a focus on 1) creating a capability to make innovative new products 2) significantly improving the production efficiency and quality of an existing product, 3) reducing total cost of ownership with all factors considered, including the impact on the environment.

Q2. Based on witness testimony, the discussion during the hearing provided a sense that it would be beneficial for the United States to have a manufacturing R&D strategy.

A2. Such a strategy should be crafted by starting with the consensus building planning process and moving to implementation. I believe there is an opportunity and necessity to do things in a different way than we have done them before, enabling delivery of results beyond what we have seen before in cycle time and new processes and new materials.

Q2a. How does a strategy get crafted?

A2a. It is important that a broad national consensus be realized. A committee to study the problem and write a report will not deliver to success that is needed. Therefore, the strategy should focus on building a national consensus. Starting with a core group with proven success in consensus building, an alliance should be grown to include hundreds of invested partners dedicated to delivering a plan for national manufacturing success, and ultimately the implementation of that plan.

1) Development of a vision for the future—much like to landing on the moon. This vision, must portray both the use of advanced technology and the development of processes and equipment to acquire that technology. Example, cars that use alternate fuels, require the development of fuel cells that are affordable and reliable.
2) Establish a high-level focal point within the Executive Branch of the Government for manufacturing productivity. This position would be responsible for inspiring the road map development and stimulating an increase in public and private collaboration. This will provide an effective means for mobilizing the Nation's resources and creating a more supportive infrastructure for the industrial transformation. Establish a well articulated agenda for building new core competencies beyond the boundaries of current product, processes, and/or corporate revitalization plans.

Q2b. Who should be included in the development of such a strategy?

A2b. It is important that this be an alliance of industry and government. The Government Agencies Technology Exchange for Manufacturing (GATE–M) was created as a grass-roots movement to better enable government agencies to work together and manufacturing technology. There are several organizations that represent the manufacturing technology interests and industry. Several of these organizations are already working together. This alliance can and should be formalized and a national manufacturing technology alliance formed that is broadly inclusive. Some specific examples of organizations working in this area are: National Center for Manufacturing Science, National Coalition for Advanced Manufacturing and Integrated Manufacturing Technology Initiative.

Q2c. What would the major elements of such a strategy be?

A2c. I believe the strategy has multiple steps.

a. Develop a plan that defines the tools and technologies needed by American industry and what must be done to deliver them.
b. Provide a clear understanding of what is being done to deliver those tools and technologies.
c. Conduct a gap analysis to determine future needs that are not adequately being addressed in develop a plan to fill those needs.
d. Create an industry/government alliance, with investment and funding from all parties, to deliver the solutions.

Six key areas for R&D investment:

- Emerging technologies
- Intelligence systems
- Model based design and manufacturing
- Enterprise integration
- Knowledge management
- Safe secure and reliable manufacturing operations

Questions submitted by Representative Nick Smith

Q1. What do you think the Federal Government should be doing to support applied manufacturing research?

A1.

- Support funding for the development of the Next Generation Manufacturing Technology Roadmap supported by Mantech.
- Establish a high-level focal point for manufacturing productivity with in the administration.
- Increase support for collaborative development by increasing funding for DOD MANTECH.

1) The Federal Government should support the development of manufacturing technologies to assure the strong defense of the Nation as well as :strengthening our global competitiveness. The government makes large investments in military systems, but relatively small investments in new tools and technologies to build those systems. The government has traditionally relied on market forces to deliver manufacturing technology advances. However, the current trend in both the defense and commercial sectors has been to in fact sharply cut such investments in order bolster near-term financials. This gap must big filled.
2) Related to National Defense, the government should invest in producing products that assure the security of homeland and aggressively combat terrorism. These missions demand the rapid design and development of detection devices, response mechanisms and other products that are not now available. New manufacturing technologies are essential in meeting this challenge.
3) The Federal Government should invest in manufacturing infrastructure that supports the economic strength of the Nation. The U.S. manufacturing sector is under increasing pressure from overseas competition. The U.S. leadership in manufacturing technology is being eroded. We must respond with a strong industry/government commitment to U.S. excellence and design and manu-

facturing. The government should provide financial assistance to collaborative activities that deliver solutions that benefit all U.S. manufacturers. Pass a collaborative R&D tax credit for joint industry-national laboratory and or university research efforts.

4) The Federal Government should run lean and efficient programs that provide fair opportunities for U.S. companies to compete for applied R&D funding. The SBIR programs and the NIST ATP programs have shown a high return on investment. There are areas for improvement in these programs, but the fundamental models are solid.

BIOGRAPHY FOR JAY R. DUNWELL

President, Wolverine Coil Spring Company, 818 Front Ave. NW, Grand Rapids, MI 49504. (616) 459–3504

Currently active on the following boards and committees:

Manufacturers Council—Vice Chair

Manufacturers Council Workforce Development Committee—Co-chair

Spring Manufacturers Institute—Board of Directors

Spring Manufacturers Institute—Education Committee

Kent/Allegan County Workforce Development Board

Workpaths.com Advisory Board

Grand Rapids Community College Tassell M–TEC Advisory Board

Butterball Farms, Inc.—Advisory Board

Grand Rapids Chamber of Commerce Family Business Council

Personal

Born October 8, 1964 in Grand Rapids, Michigan. Degree in Economics from the University of Michigan, 1987. Wife Amy, and two children, Scott (8) and Bradley (6), both enrolled in Forest Hills Public Schools' Spanish Full-Immersion Program. Enjoys hockey, soccer, coaching soccer, sailboat racing, running, and fishing.

WCS

Wolverine Coil Spring Co.
818 Front Ave. NW
Grand Rapids, MI 49504
Phone: (616) 459-3504
Fax: (616) 459-0362

June 4, 2003

To: Hon. Vernon J. Ehlers, Chairman
Environment, Technology & Standards
2320 Rayburn House Office Building
Washington, D.C. 20515-6301

From: Jay R. Dunwell, President
(616) 459-3504 ext. 127
dunwell@wolverinecoilspring.com

Subject: Financial Disclosure

Pursuant to the Rules of the House of Representatives of the United States, each person testifying before Congress who is not representing a governmental entity must reveal his or her sources and amounts of federal funding which directly supports the subject matter on which he or she is testifying.

I, Jay R. Dunwell do declare that I have not in the current fiscal year, nor the two preceding fiscal years received any federal funding.

Sincerely,

Jay R. Dunwell
President
Wolverine Coil Spring Co.

ANSWERS TO POST-HEARING QUESTIONS

Responses by Jay R. Dunwell, President, Wolverine Coil Spring

Q1. How would you define the term "Manufacturing R&D"? How does R&D for manufacturing differ from basic or applied R&D? How does R&D for manufacturing differ from basic or applied R&D?

A1. To me, "Manufacturing R&D" implies a direct focus on the improvement of manufacturing through new technology. This "improvement focus" could be in new products, new processes, new manufacturing equipment, better materials, more efficient operations, anything that pushes manufacturing to the next level.

I consider manufacturing R&D to be very similar to applied R&D—simply the application of the R&D is focused upon manufacturing challenges. Basic R&D, as others testified, often leaves a "valley of death" between the basic discovery and an economically feasible application of that discovery. Helping to bridge the "valley of death" is certainly an opportunity for government involvement.

Q2. Based on witness testimony and the discussion during the hearing, there was a sense that it would be beneficial for the United States to have a manufacturing R&D strategy. How would you recommend such a strategy be crafted? Who should be included in the development of such a strategy? What would the major elements of such a strategy be?

A2. Collaboration must be the foundation of any R&D strategy. Simply speaking, bringing together those that are advancing technology, making discoveries, with those that may possibly invent uses and applications for such discoveries needs to better coordinated. I'm sure it happens much too often where someone on the East Coast discovers something that seems to have no useful purpose, yet that same discovery could solve a problem for someone in Colorado. Yet the two never join. If the government could establish a system for connecting these parties and assisting in putting the disjointed efforts together, this would be a major step in the right direction.

Similarly, the government could assist in establishing new consortia with the purpose of pushing new technologies into commercialization. As the Manufacturers Council Position Paper highlights, expanding collaborative research consortia within the private sector and between industry and the public sector will help transfer R&D into new products and processes.

The development of a national strategy must include multiple players—federal labs, higher education, research organizations, government officials, private sector business, regional economic representatives, trade associations, small and medium sized businesses, just to name a few.

The core and most challenging element of a national strategy is the transfer of leading edge R&D to other parties. How is this coordinated? Who participates? What is the economic model that makes sense? These are the challenges that need the attention of our State and federal representatives.

Q3. What do you think the Federal Government should be doing to support applied manufacturing research?

A3. The Federal Government could and should play a key role in supporting R&D in this country. The current decline in federal spending on applied R&D must turn around. Increased spending and involvement in developing a new infrastructure are key responsibilities of the Federal Government. Key points to this include:

- Increase support of current, proven successful programs such as MEP and ATP.
- Renew our national commitment to engineering and physical sciences research.
- Expand research consortia and partnerships between industry and the public sector.

Manufacturing in the United States is under extreme pressure from foreign competition. Without a national strategic agenda supporting the manufacturing infrastructure of our country, we risk the loss of thousands of jobs and an erosion of our entire economic base. Jobs are certainly important, but not just any job will maintain the standard of living and quality of life we expect. Without a strong manufacturing sector, our quality of life cannot be maintained. The type of job matters!

BIOGRAPHY FOR JASON FARMER

Director Advanced Technology, nLight Photonics

Jason co-founded nLight in 2000 after leading the development of high power semiconductor laser technology with SBIR funding from NSF, NASA, NIH and the Air Force. Jason is responsible for all aspects of advanced technology at nLight including the exploration of new concepts, applications, and opportunities that will allow fundamental advances in the field of semiconductor lasers. Prior to co-founding nLight Photonics, Jason was a principal scientist at Aculight Corp. Jason holds a B.S. from the University of California at Santa Barbara and a M.S. from the University of Colorado at Boulder.

nLIGHT
PHOTONICS

Dear Mr. Chairman,

nLight Photonics is not currently receiving any federal funding and has not had any federal funding since the company was founded in August 2000.

Sincerely,

Jason Farmer
Director of Advanced Technology
nLight Photonics Corporation
5408 NE 88th Street, Bldg. E
Vancouver, WA 98665